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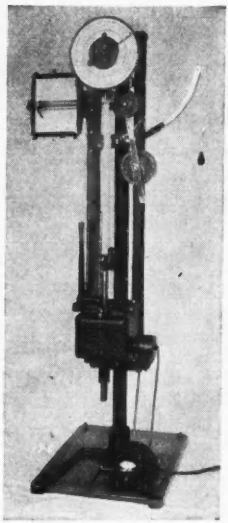

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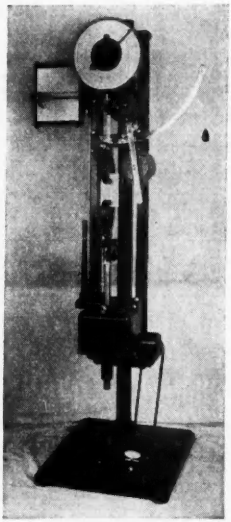

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TEXTILE RESEARCH

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The Textile Foundation, Inc.

Eleventh Annual Meeting

To Include Important Research Conferences

THE Institute's eleventh annual meeting will be held on Thursday, November 14, at the Hotel Pennsylvania, New York City. The program as tentatively arranged by the Board of Directors at a meeting in New York, Sept. 26, calls for a morning session, starting at 11 A.M. for the presentation of annual reports and other routine business, this to be followed by a luncheon open to members and guests, while the afternoon will be devoted to conferences on two important new research projects.

One of the latter relates to a proposed extension of the completed research on textile drying to cover certain subjects more exhaustively than has been possible thus far.

At the other conference there will be presented for discussion and acceptance after possible revision the tentative program for the research on Effects of Processing on the Wool Fibre, which program has been prepared by the Committee appointed following the conference on this subject at the last annual meeting.

The tentative program for this research has been approved by the Research Council and the Board of Directors, and the Council has approved the appointment of the program committee as the Administration Committee for the research, as follows: Rinaldo A. Lukens, Continental Mills, Inc., Philadelphia, Pa., Chairman; Dr. Werner Von Bergen, Forstmann Woolen Co., Passaic, N. J.; Hugh Christison, Arlington Mills, Lawrence, Mass.; E. D. Walen, Pacific Mills Worsted Division, Lawrence, Mass.; Dr. Milton Harris, Research Director, Textile Foundation, National Bureau of Standards, Washington, D. C.; Dr. A. C. Walker, Bell Telephone Laboratories, New York, N. Y.

Conferences Are Open to All Interested

As is always the case when the Institute has a new research subject to discuss or a research project to organize, they are presented at conferences open to all who are interested, irrespective of whether or not they are Institute members. It is hoped that members will not only make this fact known to their manufacturer friends who are not members, but that they will give the conferences as wide publicity as possible.

Copies of the tentative program on Effects of Processing on the Wool Fibre, including explanatory notes on the fibre properties to be studied, special problems to be considered and the processes to be studied, can be obtained by addressing Secretary Clark.

Committees

The following committees to act in connection with the annual meeting were appointed by President Killheffer at the meeting of directors September 26:

Committee on Nominations—Earl Constantine, Chairman; Arthur Besse, Ephraim Freedman, D. G. Woolf.

Budget Committee—Dr. H. DeW. Smith, Chairman; Dr. F. Bonnet, Dr. A. C. Walker, W. D. Appel.

New Foundation Directors

At the meeting of the Board of Directors of the Textile Foundation held in Washington, D. C., Sept. 20, the following three new directors were inducted into office: Claude R. Wickard, Secretary of Agriculture; Jesse H. Jones, Secretary of Commerce and Federal Loan Administrator; Donald Comer, Chairman, Avondale Mills, Birmingham, Alabama, who had been appointed August 15 by President Roosevelt to fill the unexpired term of the late Stuart W. Cramer. To succeed Mr. Cramer as Treasurer, the Board elected Frank D. Cheney who had been a director since 1933.

At this first meeting since the death of Stuart W. Cramer, who had been a director and Treasurer of the Foundation since it was created by Congress in 1930, resolutions expressing profound sorrow at his passing were unanimously adopted.

Following routine business and reports, a proposal submitted by Mr. David Clark, editor of the *Textile Bulletin*, and Mr. Marshall Dilling, on behalf of the Southern Textile Association, designed to extend practical research in the cotton manufacturing industry, was discussed and taken under consideration.

Effects of Drying Conditions on Properties of Textile Yarns

By JAMES G. WIEGERINK *

Abstract

Yarns made from raw cotton, "purified" cotton, mercerized cotton, clothing wool, carpet wool, viscose rayon, cuprammonium rayon, cellulose acetate, and degummed silk were saturated with water and then exposed for periods of 1/2 to 6 hours in air having temperatures of 221°, 257°, and 302° F. and absolute humidities of approximately 1%, 55%, and 95%. After conditioning the dried yarns for at least 24 hours in air of 65% relative humidity and 70° F., measurements were made of the breaking strengths, elongations at break, and moisture contents of the yarns; the fluidities of dispersions of the cellulosic fibres in cuprammonium solution, of the silk in aqueous zinc chloride, and of the acetate in aqueous acetone; and the relative affinities of the cellulosic fibres for the dye Benzopurpurine 4B and of the wools for acid dyes.

Heating for 6 hours at 221° F. and each of the three humidities weakened all of the yarns. The breaking strength and elongation at break of the viscose, cuprammonium, degummed silk, and cotton yarns decreased still more at higher temperatures. In comparison with heating at 1% absolute humidity, heating at 95% absolute humidity resulted in lower breaking strengths and elongations at break for all yarns except the raw cotton, higher fluidities, lower affinity of cellulosic fibres and higher affinity of wool fibres for the dyes.

Heating for 1/2 hour at 302° F. had little effect on the properties of the yarns except the viscose and cuprammonium rayon which were adversely affected. The damage which occurred at a given temperature and humidity increased throughout the heating period.

Introduction

ALTHOUGH it is common knowledge that textile fibres are degraded at elevated temperatures, the combined effects of heat and moisture have received little study. Therefore, particular attention was given to this subject in the course of the studies of textile drying carried out by the United States Institute for Textile Research and the National Bureau of Standards.

The materials which are dried in the various branches of the textile industry, including laundries and drycleaning plants, and the procedures used are so various that no one set of materials and conditions can be

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considered representative of all of them. By limiting the work to yarns made from the common fibres freed from the natural non-fibrous materials which would be removed from them in the course of manufacture, and to controlled and duplicable conditions of temperature, relative humidity, airflow, and thoroughness of exposure, it was possible to obtain data which may be considered basic to all types of textile drying. The results are given in this paper.

Materials

The characteristics of the yarns and the purification treatments they received are given below. Where treatment with water was indicated, distilled water was used.

The raw cotton yarn (1/24) * was washed thoroughly in water. The "purified" cotton yarn was prepared from the raw cotton yarn by successive extractions with alcohol, ether, and 1% NaOH solution, followed by rinsing in 5% acetic acid solution and then in water. The mercerized cotton yarn (2/25) was washed in a 5% NH_4OH solution, then rinsed in water. The clothing wool yarn (2/2.3) and the carpet wool yarn (3/1.2) were extracted with alcohol and ether, and rinsed in warm water. The viscose rayon yarn (1/30; commercial designation 150 denier, 40 filament), the cuprammonium rayon yarn (1/30; commercial designation 150 denier, 112 filament), and the cellulose acetate yarn (1/30; commercial designation 150 denier, 46 filament) were washed in a warm 1% NH_4OH solution, then rinsed in warm water. The degummed silk yarn was prepared from a raw silk yarn (4/75) by degumming with an olive oil soap solution, followed by rinsing in warm water.

Procedure

The equipment for this investigation is described in detail in a previous paper.[1] It provides means for controlling the temperature and humidity of air, for passing a stream of this air through a working chamber at a known rate, for supporting samples in this chamber so they are well exposed to the air stream, and for sampling the air in the working chamber and accurately determining its humidity by a gravimetric measurement of the moisture content. The temperature in the working chamber was maintained constant within $\pm 1°$ F. and the humidity within $\pm 1\%$ humidity throughout each test. Three humidities at each temperature were studied. Hereafter, where a low, medium, and high humidity are referred to, absolute humidities of approximately 1%, 55%, and 95%, respectively, are meant. Relative humidities corresponding to these absolute humidities are also included for comparison.†

The samples for test were soaked overnight in distilled water. The following day the excess water was removed by squeezing the yarns until their weights were approximately 50% more than their "dry" weights (determined by heating other samples in an oven at 220° F. for over 12 hours). The samples were then placed in the working chamber, which was maintained at the definite temperature and humidity of the test. The samples were kept in the chamber for different intervals of time ranging from

* The typp system for designating sizes of yarns is employed.

† The term "relative humidity" as used in this report is the ratio of the actual pressure of water vapor to the maximum possible pressure of water vapor in the atmosphere at the same temperature, expressed as a percentage. The term "absolute humidity" as used in this report is the actual percentage by volume of water vapor in the system.

1/2 to 6 hours. All samples came to practically constant weight before removal from the working chamber and consequently contained an amount of moisture consistent with the relative humidity and temperature of the test. These equilibrium values at the various relative humidities and temperatures are reported in a previous paper.[2] It must be noted that all samples were placed in the working chamber wet and that during evaporation of the moisture the textile was at a lower temperature than that indicated by the dry-bulb temperature in the working chamber. Thus, where a 1/2- to 1-hour heat treatment at a certain dry-bulb temperature is indicated, the samples, although dried to equilibrium before being taken from the working chamber, may have been at the dry-bulb temperature for less than 15 minutes during the 1/2-hour exposure, and less than 1/2 hour during the 1-hour exposure.

The samples were removed from the working chamber and conditioned for at least 24 hours in an atmosphere of 65% relative humidity at 70° F. They were tested in this atmosphere using a pendulum single-strand tester. The distance between the jaws of the testing machine at the start of each test was 10 inches, and the speed of separation of the jaws was 12 inches per minute. The breaking strength and elongation at break were observed.

The fluidities of dispersions in cuprammonium solution of the dried raw cotton, the purified cotton, and the viscose rayon were measured with the method described by Mease.[3] These dispersions contained 0.5 g. of the cotton, or 2.5 g. of the viscose rayon, dry basis (calculated from the moisture content determined on a duplicate sample), for 100 ml. of dispersion. Measurements were made of the fluidity of the dried degummed silk in aqueous zinc chloride solution, density 1.67 at 70° F., 2.5 g. of the silk, dry basis, being used for 100 ml. of solvent. The weighed amount of the silk, cut into small pieces, was introduced into a small flask, and the required volume of zinc chloride solution added. The flask was then stoppered and placed in an oven at 113° F. for three hours with occasional swirling of the flask to ensure mixing of the contents. The solution was then cooled to 70° F., transferred to a viscosimeter, and the viscosity measured at 70° F.[4]

The fluidity of the dried cellulose acetate was measured in aqueous acetone, density 0.81, at 70° F., 2.5 g. of the acetate, dry basis, being used for 100 ml. of solvent. The weighed amount of acetate was dissolved in the required volume of acetone, and kept at 70° F. overnight. In the morning the solution was transferred to a viscosimeter and the viscosity at 70° F. measured. The fluidities of the original samples, not dried, were measured for comparison with the dried samples.

The moisture contents of the heat-treated yarns after conditioning for 24 hours or more in an atmosphere of 65% relative humidity and 70° F. were determined in the usual manner.

The heat-treated cellulosic yarns, namely, viscose rayon, cuprammonium rayon, purified cotton, and mercerized cotton, were dyed with a solution containing 0.5% of Benzopurpurine 4B and 10% of NaCl based on the weight of the yarn. The heat-treated clothing and carpet wools were dyed with a solution containing 0.3% of Alizarine Astrole B, 0.1% of Fast Light Yellow 2G, 0.25% of Neolan Red 3B, 20% of Glauber's salt, and 5% of sodium bisulfate. The dyed yarns were wound on dark cardboard and their spectral reflectances relative to magnesium oxide were determined at a wavelength of 501 millimicrons. This wavelength was chosen after a study of the complete reflectance curves (400 to 740 λ) for typical samples.

The cystine contents of the heat-treated samples of clothing wool were determined by the Sullivan method.[5]

Results and Conclusions

Tables 1 to 9 give the breaking strengths, elongations at break, and "quality indices" of the yarns after being heated at different humidities for various periods of time and then exposed to the standard conditions of 65% relative humidity and 70° F. for at least 24 hours. Each value is the average of 25 tests. The "quality index" is the percentage of the original breaking strength after drying multiplied by the percentage of the original elongation after drying. It appears to be useful in analyzing the results.

TABLE 1

Viscose Rayon Yarn

Temp. °F.	Relative Humidity* (%)	Absolute Humidity* (%)	Time of Exposure (hrs.)	Breaking Strength (as % of original)	Elongation at Break (as % of original)	Quality Index
221	1	1	1	95	97	92
			1½	94	97	91
			6	90	89	80
221	48	57	1½	99	93	92
			3	100	91	91
			6	97	84	81
221	79	94	1½	96	97	93
			4	97	91	88
			6	90	83	75
257	0.5	1	½	92	91	84
			1½	85	79	67
			6	72	67	48
257	24	55	¾	96	86	82
			1¾	85	72	61
			6	72	56	40
257	42	96	½	99	93	92
			1½	90	82	74
			6	68	57	38
302	0.2	0.5	½	73	61	45
			1½	67	58	39
			6	50	42	21
302	12	56	½	69	54	37
			1½	57	38	22
			6	45	23	10
302	20	96	½	83	70	58
			1½	60	50	30
			6	43	27	11

* See footnote †.

TABLE 2

Cuprammonium Rayon Yarn

Temp. °F.	Relative Humidity (%)	Absolute Humidity (%)	Time of Exposure (hrs.)	Breaking Strength (as % of original)	Elongation at Break (as % of original)	Quality Index
221	1	1	1	100	94	94
			2	100	94	94
			6	100	94	94
221	48	57	1½	97	85	82
			3	94	76	71
			6	86	67	58
221	79	94	2	98	79	77
			4	96	61	59
			6	92	58	53
257	0.5	1	½	100	97	97
			1½	96	91	87
			6	96	85	82
257	24	55	¾	97	85	82
			1¾	89	70	62
			6	77	55	42
257	42	96	1	98	79	77
			2	87	58	50
			6	76	45	34
302	0.2	0.5	½	94	79	74
			1½	93	73	68
			6	76	55	42
302	12	56	½	89	73	65
			1½	79	60	47
			6	65	36	23
302	20	96	½	86	67	58
			1½	71	42	30
			6	56	24	13

The relationships between temperature and humidity of drying on the one hand, and quality index, fluidity, moisture content, and affinity for dyes of the dried conditioned fibres on the other hand, are shown in Figures 1 to 4, respectively. The data are for the 6-hour treatment, the maximum time of exposure used in the experiments. The solid lines in the figures indicate the averages of the values for the different humidities at constant temperature. These lines show in a general way the effects of heat, while the departures of the points show the effects of humidity. It should be emphasized that the results and conclusions based on them apply only to the samples examined. Further work is necessary to determine what variation is to be expected in different lots of the same fibre, or when the fibres contain oils, sizing materials, and dyes.

Fig. 1 shows that the quality indices of all of the yarns were adversely affected by the temperatures at which the yarns were heated. All were decreased by heating for 6 hours at 221° F., and the lowering of the quality indices for the viscose and cuprammonium rayons, the degummed silk, and the cotton yarns was greater as the temperature was increased. Heating in air of an absolute humidity of approximately 95% tended to give lower quality indices for all of the yarns, except the raw cotton, than heating in air of an absolute humidity of approximately 1%. The greatest effect of humidity was obtained with the cuprammonium rayon whose behavior was in marked contrast to that of the viscose rayon in this respect. Indeed, the effect of the humidity of the air on the quality index of cuprammonium

TABLE 3

Clothing Wool Yarn

Temp. °F.	Relative Humidity (%)	Absolute Humidity (%)	Time of Exposure (hrs.)	Breaking Strength (as % of original)	Elongation at Break (as % of original)	Quality Index	Cystine Content (%) (original =11.5)
221	1	1	1	102	100	102	—
			2	99	100	99	—
			6	95	93	88	11.3
221	48	57	1½	95	97	92	—
			3	91	91	83	—
			6	91	91	83	11.2
221	79	94	2	100	100	100	—
			4	97	89	86	—
			6	95	86	82	9.6
257	0.5	1	½	100	100	100	—
			1½	91	93	85	—
			6	91	93	85	11.3
257	24	55	¾	105	98	103	—
			1¾	97	97	94	—
			6	95	93	88	11.1
257	42	96	1	100	98	98	—
			2	98	93	91	—
			6	94	89	84	9.5
302	0.2	0.5	½	99	100	99	—
			1½	92	97	89	—
			6	91	93	85	10.3
302	12	56	½	107	93	100	—
			1½	93	91	85	—
			6	91	91	83	10.3
302	20	96	½	100	97	97	—
			1½	96	93	89	—
			6	90	85	77	8.8

TABLE 4

Carpet Wool Yarn

Temp. °F.	Relative Humidity (%)	Absolute Humidity (%)	Time of Exposure (hrs.)	Breaking Strength (as % of original)	Elongation at Break (as % of original)	Quality Index
221	1	1	1	92	100	92
			2	87	95	83
			6	87	85	74
221	48	57	1½	89	90	80
			3	87	85	74
			6	87	85	74
221	79	94	2	78	90	70
			4	78	85	66
			6	78	77	60
257	0.5	1	½	95	100	95
			1½	91	90	82
			6	89	85	76
257	24	55	¾	84	85	71
			1¾	81	80	65
			6	86	85	73
257	42	96	1	81	90	73
			2	84	80	67
			6	82	80	66
302	0.2	0.5	½	94	100	94
			1½	89	90	80
			6	86	85	73
302	12	56	½	87	90	78
			1½	84	90	76
			6	81	85	69
302	20	96	½	89	85	76
			1½	83	75	62
			6	81	75	61

rayon was as great as that of the change in temperature from 221° to 302° F.

The effects of heat on the clothing and carpet wool yarns were less than the effects of humidity as measured by the quality index, the average line being nearly horizontal. This is particularly true of the carpet wool yarn which shows the greatest degradation at the high humidity. The results also indicate that the carpet wool is less resistant to heat and humidity than the corresponding clothing wool yarn.

Fig. 1 indicates that heat had a greater effect on the quality indices of the purified and the raw cotton yarns than on the wool yarns. The purified cotton yarn was less resistant to heat treatment than the raw cotton yarn. The high humidity had a more degrading effect at constant tempera-

ture on the purified cotton yarn than the low humidity, but the raw cotton yarn was scarcely affected. This difference in behavior between the raw and the purified cotton yarns may be attributed to a protective action of the natural waxes in the raw cotton, which are removed by the caustic purification.

It appears from the results for the mercerized cotton and the acetate yarns that the effect of humidity, particularly the high humidity, which had the greatest degrading effect, was relatively more important than the effect of heat. In fact, the high humidity at 221° F. gave the lowest quality index for the acetate yarn.

This low quality index for the acetate yarn dried at 221° F. at the high humidity may be explained by the data given in Table 9. The breaking strength of the acetate yarn was found to decrease only when heated at 221° F. at the high humidity. At any of the other conditions studied there was no significant decrease in the breaking strength. On the other hand, there were appreciable variations in the elongation, which was lower at a high humidity at each temperature than at a low humidity. The

TABLE 5

"Purified" Cotton Yarn

Temp. °F.	Relative Humidity (%)	Absolute Humidity (%)	Time of Exposure (hrs.)	Breaking Strength (as % of original)	Elongation at Break (as % of original)	Quality Index
221	1	1	1½	99	97	96
			6	95	97	92
221	48	57	1½	100	98	98
			6	93	91	85
221	79	94	1½	91	94	86
			6	87	89	77
257	0.5	1	1½	100	102	102
			6	92	93	86
257	24	55	1½	93	89	83
			6	85	87	74
257	42	96	1½	87	90	78
			6	78	81	63
302	0.2	0.5	½	98	95	93
			1½	94	93	87
			6	84	82	69
302	12	56	½	92	90	83
			1½	79	80	63
			6	68	67	46
302	20	96	½	96	100	96
			1½	82	85	70
			6	58	69	40

TABLE 6

Raw Cotton Yarn

Temp. °F.	Relative Humidity (%)	Absolute Humidity (%)	Time of Exposure (hrs.)	Breaking Strength (as % of original)	Elongation at Break (as % of original)	Quality Index
221	1	1	1½	95	94	89
			6	94	93	87
221	48	57	1½	89	100	89
			6	92	95	87
221	79	94	1½	93	95	88
			6	95	92	87
257	0.5	1	1½	89	90	80
			6	88	90	79
257	24	55	1½	98	95	93
			6	93	90	84
257	42	96	1½	90	90	81
			6	92	88	81
302	0.2	0.5	½	96	90	86
			1½	94	90	85
			6	89	84	75
302	12	56	½	94	90	85
			1½	91	85	77
			6	89	80	71
302	20	96	½	85	90	77
			1½	89	86	77
			6	84	83	70

yarns dried at the high humidity were more brittle than the yarns dried at the low humidity, even after conditioning. The fact that there was a decrease in breaking strength of the yarns heated at 221° F. at the high humidity may indicate that this particular condition aids hydrolysis. The water in the acetate yarn before drying would be evaporated more slowly at 221° F. at the high humidity than at any of the other conditions studied. It appears that carpet wool, which lends itself to hydrolysis, also showed a similar effect at this particular condition. It should be mentioned that the acetate yarns were under no tension during the drying treatments, so that this factor does not enter into the above considerations.

The effect of heat on the quality index of the degummed silk (Fig. 1) was approximately of the same order as the effect on the purified cotton yarn. However, the effect of humidity at 302° F. was somewhat different. The high humidity at 221° and 257° F. had greater effect than the low humidity at these temperatures. No differences at 302° F. in respect to humidity are indicated.

Fig. 2 shows the relationships between temperature and humidity of drying, and fluidity for some of the yarns. The fluidities of the purified cotton and the viscose rayon in cuprammonium solution, of the degummeed silk in aqueous zinc chloride, and of the acetate in aqueous acetone were increased by heating for 6 hours at 221° F. and these increases in fluidity were greater as the temperature was increased. The fluidities were higher after treatment at the high humidity than at the low humidity. This increase in fluidity indicates greater degradation, and corresponds well with the quality indices of the dried fibres mentioned above. The fluidities of the dried raw cotton in cuprammonium solution, however, did not change with change in humidity at constant temperature, an effect which was also found to be true for the quality indices.

TABLE 7

Mercerized Cotton Yarn

Temp. °F.	Relative Humidity (%)	Absolute Humidity (%)	Time of Exposure (hrs.)	Breaking Strength (as % of original)	Elongation at Break (as % of original)	Quality Index
221	1	1	1	91	90	82
			2	92	95	87
			6	108	105	113
221	48	57	1½	92	95	87
			3	98	96	94
			6	105	97	102
221	79	94	2	92	94	86
			4	97	95	92
			6	94	93	87
257	0.5	1	½	96	96	92
			1½	92	94	86
			6	99	96	95
257	24	55	¾	97	96	93
			1¾	88	90	79
			6	100	98	98
257	42	96	1	87	92	80
			2	92	90	83
			6	88	89	78
302	0.2	0.5	½	94	93	87
			1½	90	91	82
			6	92	95	87
302	12	56	½	97	95	92
			1½	87	89	77
			6	91	93	85
302	20	96	½	93	90	84
			1½	88	89	78
			6	89	89	79

TABLE 8

Degummed Silk Yarn

Temp. °F.	Relative Humidity (%)	Absolute Humidity (%)	Time of Exposure (hrs.)	Breaking Strength (as % of original)	Elongation at Break (as % of original)	Quality Index
221	1	1	1	96	100	96
			2	96	100	96
			6	96	100	96
221	48	57	1½	100	92	92
			3	98	88	86
			6	93	90	84
221	79	94	2	99	92	91
			4	99	92	91
			6	99	90	89
257	0.5	1	½	99	99	98
			1½	96	93	89
			6	93	88	82
257	24	55	¾	94	85	80
			1¾	91	84	76
			6	89	81	72
257	42	96	1	100	86	86
			2	99	84	83
			6	89	78	69
302	0.2	0.5	½	90	89	80
			1½	88	84	74
			6	74	75	56
302	12	56	½	93	98	91
			1½	92	85	78
			6	76	74	56
302	20	96	½	96	91	87
			1½	95	89	85
			6	76	74	56

Although the viscose rayon gave lower values of quality index for the high humidity at a given temperature, the differences were small. However, Fig. 2 indicates that the effect of humidity is important. The fluidities are much higher at the high humidity than at the low humidity, which indicated that at the temperatures studied the high humidity has a greater degrading effect than a low humidity.

Fig. 3 shows the effects of heat and humidity on the moisture contents of the various textile materials when conditioned in an atmosphere of 65% relative humidity and 70° F. These values are given for the 6-hour treatment.

Each of the dried yarns failed to regain the amount of moisture it held originally. Yarns heated at the high humidity had a lower moisture

TABLE 9

Acetate Yarn

Temp. °F.	Relative Humidity (%)	Absolute Humidity (%)	Time of Exposure (hrs.)	Breaking Strength (as % of original)	Elongation at Break (as % of original)	Quality Index
221	1	1	1	100	98	98
			2	94	95	89
			6	94	95	89
221	48	57	1½	98	90	88
			3	98	93	91
			6	98	93	91
221	79	94	2	82	84	69
			4	83	85	70
			6	82	84	69
257	0.5	1	½	99	95	94
			1½	96	91	87
			6	95	95	90
257	24	55	¾	99	95	94
			1¾	98	95	93
			6	93	92	86
257	42	96	1	100	87	87
			2	99	84	83
			6	100	86	86
302	0.2	0.5	½	98	95	93
			1½	100	95	95
			6	100	92	92
302	12	56	½	100	91	91
			1½	98	91	89
			6	96	88	84
302	20	96	½	103	87	90
			1½	102	85	87
			6	96	84	81

content on conditioning than those heated at the low humidity, with the exception of the acetate yarn. The moisture contents of the acetate yarns on conditioning show little effect with respect to humidity, but the effect of heat is important. For example, yarns heated at 302° F. for 6 hours had a moisture content of only 5.3% on conditioning at 65% relative humidity, 70° F., as compared with the 7.3% moisture content of the original sample for the same conditions.

Fig. 4 shows the effects of the 6-hour treatments on the affinities of the various textile materials for dyes, as measured by changes in their spectral reflectances relative to MgO. An examination of Fig. 4 shows that the affinity of the dried cellulosic fibres for the dye Benzopurpurine 4B decreased, as indicated by the higher reflectance values. Also, the fibres

heated at the high humidity for a given temperature adsorbed less of this dye than when heated at the low humidity. This is in agreement with the physical and chemical data given above.

The wool yarns, on the other hand, when degraded by heat and humidity treatments adsorbed more the acid dyes. The wool yarns heated at the high humidity at a given temperature adsorbed more of the acid dyes than when heated at the low humidity, as indicated by the lower

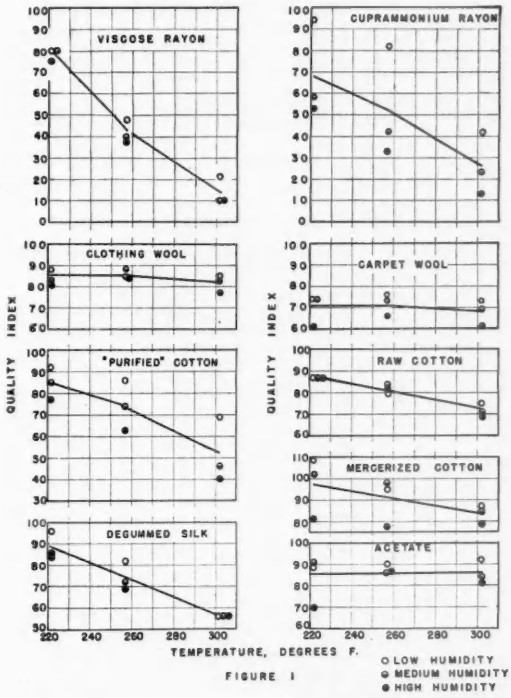

Fig. 1. The relationship between quality index and temperature of drying at different humidities for 6-hour time of exposure.

reflectance values. In fact, there is little difference in the reflectance at a low humidity for any of the temperatures investigated, but a high humidity even at the lowest temperature investigated, 221° F., gave low reflectance compared with the original. This difference in affinity of the dried clothing wool yarn for dyes corresponds to the difference in the cystine content (see Table 3).

Fig. 5 shows the relationship between breaking strength and fluidity of the dried and conditioned textile materials. The curves for the viscose rayon, the purified cotton, and the degummed silk indicate linear relations

between fluidity and breaking strength provided the humidity is taken into consideration. Little relationship was found between breaking strength and fluidity for the raw cotton. The changes in breaking strength and fluidity are small compared with those of the viscose rayon and the purified cotton yarns. The sharp break upwards in the curve for the raw cotton

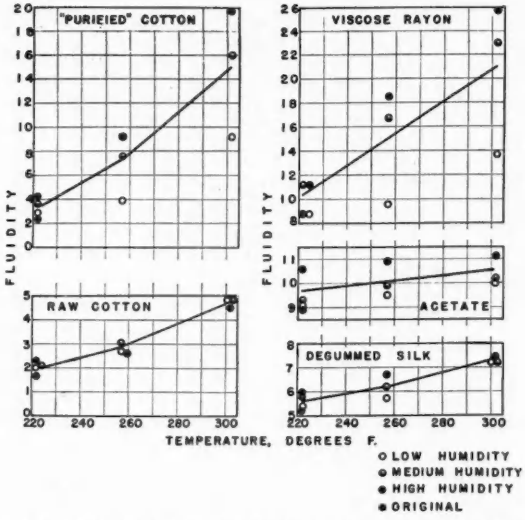

Fig. 2. The relationship between fluidity and temperature of drying at different humidities for 6-hour time of exposure.

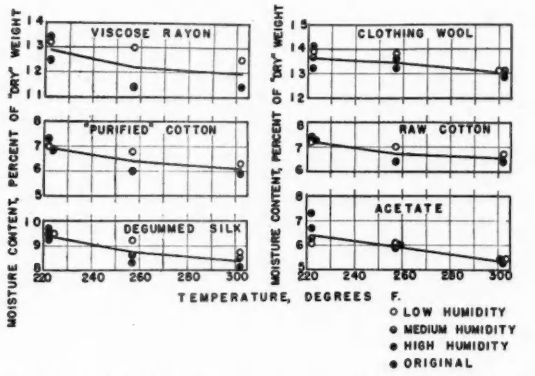

Fig. 3. The relationship between moisture content on conditioning and temperature of drying at different humidities for 6-hour time of exposure.

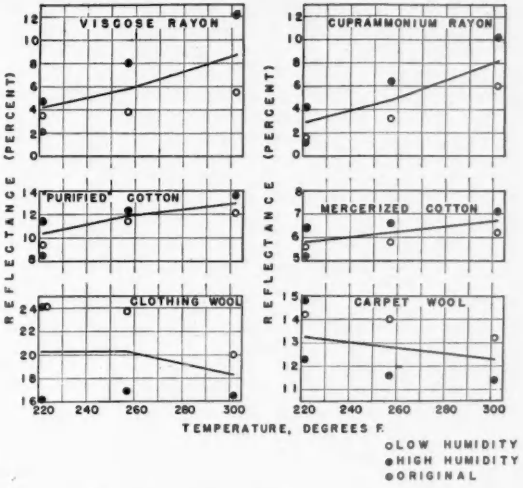

Fig. 4. The relationship between reflectance and temperature of drying at different humidities for 6-hour time of exposure.

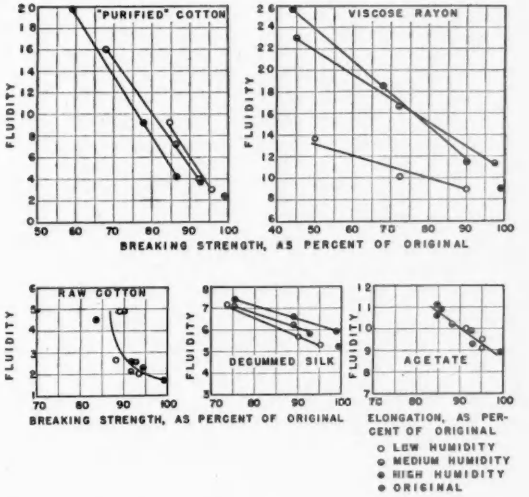

Fig. 5. The relationship between fluidity and breaking strength as a function of humidity.

yarn does indicate that the fluidity is more sensitive to changes in the fibre than the breaking strength of the yarn.

The acetate yarn is peculiar in that no relationship was found between breaking strength and fluidity. However, elongation plotted against the corresponding fluidity gave an approximate linear relationship. This indicates that breaking strength is the least sensitive of the criteria used for judging degradation in the acetate yarn.

Fig. 6 shows a definite relationship between the reflectance and the chemical and physical properties. The reflectances of the purified cotton

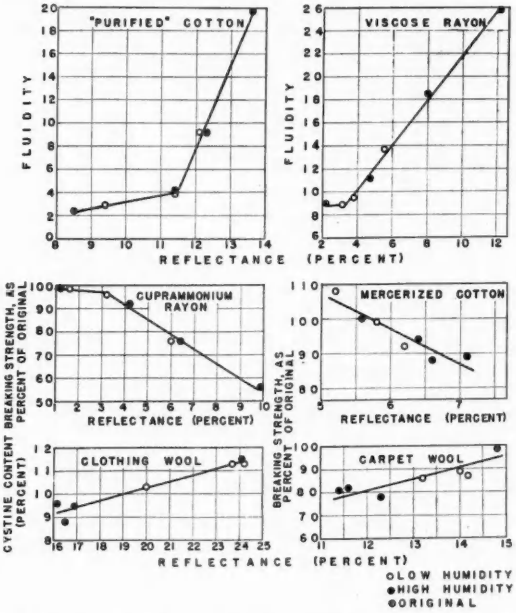

Fig. 6. The relationship between reflectance and the physical and chemical data as a function of humidity.

and the viscose rayon yarns change more rapidly than the fluidities in the first stages of apparent degradation. This may indicate, merely, that the dye test measures surface changes in the yarns, and the fluidity measures mainly chemical changes.

The time of heating is also important. The conclusions mentioned above were drawn on the basis of the data for the 6-hour treatment. The tables give the results for short intervals of time as well as for the 6-hour period. An examination of Tables 1 to 9 shows that for the shorter periods studied, 1/2, 3/4, and 1 hour, most of the materials underwent very little decrease in breaking strength. A slightly greater effect on elongation at break is indicated. Several exceptions, however, are noted. There was

some lowering in breaking strength and elongation at break of the carpet wool and acetate yarns when heated for a 2-hour period at 221° F. at the high humidity. The viscose and cuprammonium rayon yarns, which were the least resistant to heat of all the materials studied, showed a decrease in breaking strength and elongation if heated for only 1/2 hour at 302° F. The purified cotton yarn showed a small decrease in quality index on heating for 1/2 hour at 302° F.

There was an increase in fluidity of the viscose rayon yarn after heating for a short period at 257° F. at the high humidity, and for a short period at 302° F. at all three humidities. The fluidity of the purified cotton yarn was approximately 4.0 rhes after 1/2-hour treatment at 302° F. at all humidities, 9.1 rhes after 1 1/2-hour at 302° F. at the high humidity, as compared to the original sample with a fluidity of 2.4 rhes.

There was an increase in reflectance of dyeings of the viscose rayon, cuprammonium rayon, and purified cotton heated for only short periods of time, indicating a decrease in affinity for the dye. For example, dyeings were prepared after heating the yarns at 302° F. for 1-1/2 hours at the low humidity and at the high humidity. The reflectances of the untreated yarns, yarns treated at the low humidity, and yarns heated at the high humidity, respectively, were: viscose rayon, 2.1%, 4.4%, and 5.7%; cuprammonium rayon, 1.2%, 1.7%, and 4.3%; "purified" cotton, 8.5%, 10.8%, and 10.7%.

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A Method of Fibre-Length Analysis Using the Fibrograph

By DR. K. L. HERTEL *

Abstract

The fibrograph is an optical instrument employing photovoltaic cells for scanning samples of parallel fibres and tracing a type of length-frequency curve. The theory is developed for a sample of parallel fibres in which the fibres are positioned at random. The geometrical interpretation of the resulting curve, or fibrogram, indicates simple length and area measurements that give various average lengths and statistical quantities, such as standard deviation and coefficient of variation. Experimental fibrograms are compared with the equivalent data derived from absolute length measurements, using a projection method. The waviness and taper of the fibres, along with other minor factors, cause the fibrogram to be too short. When the length coördinates are increased 19%, the fibrogram is equivalent to the curve obtained from absolute measurements. The instrument makes possible the rapid measurement of fibre length and fibre-length uniformity of raw fibre samples.

Introduction

LENGTH is recognized as one of the important physical properties of textile fibres. A single length designation is used to represent a whole population in which the individuals vary over a wide range. Such a length must be an average or representative length, and its value will depend upon the method of averaging as well as the length of the fibres. The familiar staple length seems to be such a representative length, but the type of average which it represents is unknown even to the classer himself, and probably varies from classer to classer.

Staple length appears to be a subjective concept that resides in the mind of the classer and is maintained reasonably constant by reference to standards that have been agreed upon but never defined in terms of measured physical properties. Until staple length can be uniquely defined, it cannot be measured reliably by an instrument.

Representative fibre lengths have been determined also with the aid of instruments. The methods fall into two groups. In one group, the fibres are sorted as to length and then the weight or number of fibres in each fraction determined to give the necessary data for plotting a type of length-frequency curve. In the other group, a sample of paralleled fibres is measured at various positions by some scheme and these measurements are converted into number of fibres to give the necessary data for plotting a length-frequency curve. The method to be discussed here belongs in the latter group.

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The instrument called the fibrograph is designed to combine several operations, so that a type of length-frequency curve can be traced directly by the instrument. When the sample is prepared in a particular way various average lengths are represented as distances on the resulting curve, or fibrogram. Such a procedure makes it possible to compare methods of averaging, as well as resulting average fibre lengths, with practical usage so that the optimum for both may eventually be ascertained. In addition, it is easy to obtain from the fibrogram a measure of length uniformity. It is the purpose of this paper to set forth the underlying principles involved in the method of analysis and the use of the resulting fibrogram rather than to give results obtained in various experiments using the method.

Theory

The distribution of the lengths in a fibre population is frequently represented by a length-frequency distribution curve. One such curve is shown at the left of Fig. 1. Here p(l) is the probability that a fibre of the population has a length between l and l + dl. If

$$q(l) = \int_l^{l_m} p(l)dl$$

where l_m is the length of the longest fibre, q(l) is the probability that a fibre of the population has a length at least as great as l. q(l) also has a graphical interpretation. If the fibres of the population were laid horizontally with their left ends on the vertical axis, equally spaced, and in order of their lengths, the right ends of the fibres would form points on the curve. The area under q(l) would be uniformly covered with fibre. If a fibre is to be selected at random and every point on every fibre is equally probable, the probability that the selection will fall within a certain region is the ratio of the area of the region to the whole area. The probability, therefore, that the left-hand portion of a selected fibre extends a distance at least as great as l from the point of selection is the area to the right of l divided by the whole area, $= \dfrac{\int_l^{l_m} q(l)dl}{\int_0^{l_m} q(l)dl}$ or $\dfrac{r(l)}{L}$ where $r(l) = \int_l^{l_m} q(l)dl$ and L is the mean length of the fibres, since $\int_0^{l_m} q(l)dl = l(0) = L$.

The curve r(l) has an interpretation similar to that of q(l). If the randomly selected fibres were arranged with their points of selection, rather than their left ends, along the vertical axis, their right ends would form r(l). One method of obtaining such a sample, except for the arrangement in order of length, is to clamp a sliver of randomly distributed parallel fibres along a line and comb out all loose fibres on the right side of the line. The sample thus obtained is the "fibre-beard" of Braschler and others. Such a sample is represented by r(l), which is the second integral of p(l) as shown above and shown previously by another method [1] and not by the modified second integral suggested by Braschler.[2] It is true that the clamped fibres have a greater proportion of long fibres, but it is just this bias that is necessary to make the sample fit the unmodified second integral of p(l).

An optical instrument called the fibrograph has been developed to scan a sample of paralleled fibres and simultaneously plot a curve called a fibrogram.

When the sample consists of paralleled fibres with their ends aligned, as is the case of fibres attached to the seed, the curve has been called the seed-cotton fibrogram and is the equivalent of q(l). When, however, the sample consists of paralleled fibres clamped at random by a straight edge normal to their lengths, loose fibres having been combed out, the fibrogram is the equivalent of r(l).

The fibrogram and its theoretical equivalent, r(l), have geometrical properties that make them particularly suitable to the analysis of fibre lengths. The suitability and versatility of the fibrogram may be suspected when it is remembered that it is equivalent to the second successive integral of the length-probability curve, and therefore should readily yield mean lengths. In addition, the fibrogram is a graphical representation of the fibres distributed at random, and this particular distribution is found universally from gin to finished product.

The fibrogram has been studied in order to learn how the significant properties of the cotton can be obtained from it. For instance, the mean length of the fibre is given by the intercept on the length axis of a tangent to the fibrogram. In Fig. 1(r) the tangent at r(0) intercepts the l axis at the mean length L. This must be true because the greatest ordinate of r(l) is L, and since $dr/dl = -q(l)$ and q(0) is unity, the tangent at $l = 0$ must have a slope of -1, and hence must intercept the length axis at L. Fibrograms will have different vertical dimensions if the samples differ in their total number of fibres, but the horizontal dimensions will remain unaltered. The tangent at $l = 0$ will always intercept the length axis at the mean length on any fibrogram of the r(l) type.

It is interesting to investigate the significance of the intercepts for other tangents. For this purpose, the curves of Fig. 1 may be transformed by

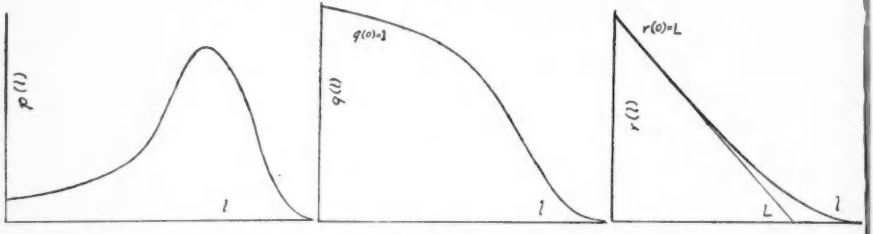
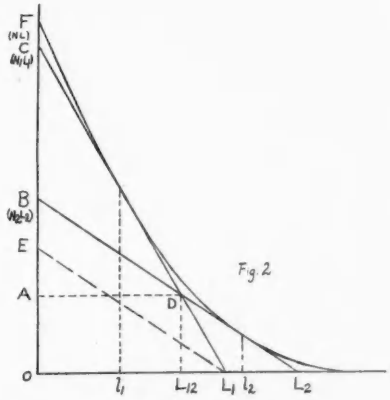


Fig. 1.

multiplying the ordinate scale by the total number of fibres, N, as is shown for r(l) only in Fig. 2. p(l) becomes a length-frequency curve; the greatest ordinate for q(l) becomes N; and the greatest ordinate for r(l) becomes NL, the combined length of all the fibres. If now all the fibres shorter than l_1 are disregarded, q(l) becomes horizontal from its value at $l = l_1$ to $l =$ zero. Under the same conditions r(l) maintains a constant slope $dr/dl = -q(l_1)$ from its value at l_1 to zero and ends at C, Fig. 2. The fibres longer than l_1 may be considered a partial sample. If N_1 is the total number of fibers in the partial sample and L_1 is their mean length, the tangent to r(l) at l_1 intersects the length axis at the mean length, L_1, of the partial sample (fibres longer than l_1), and intersects the vertical axis at N_1L_1, which is the combined length

of all the fibres in the partial sample (fibres longer than l_1). In general, the tangent to r(l) at any point intersects the length axis at the mean length of those fibres longer than the length represented by the point of tangency and intersects the vertical axis at a point such that its ordinate is proportional to the combined length of those fibres.



The coördinates of the point of intersection of two tangents also are significant. Using the conventional x and y coördinates, the equations for the two tangents are

$$y = -N_1x + N_1L_1$$

and

$$y = -N_2x + N_2L_2$$

from which

$$x = \frac{N_1L_1 - N_2L_2}{N_1 - N_2} = L_{12}$$

the mean length of all fibres longer than l_1 and shorter than l_2.

Substituting L_{12} for x

$$N_1L_1 - y = AC = N_1L_{12}$$

and

$$N_2L_2 - y = AB = N_2L_{12}$$

$$\therefore \quad \frac{AB}{AC} = \frac{N_2}{N_1}$$

which is the ratio of the number of fibres longer than l_2 to the number longer than l_1. If EL_1 is parallel to BD,

$$\frac{EO}{OC} = \frac{N_2}{N_1}, \quad \text{the ratio by number}$$

$$\frac{BO}{CO} = \frac{N_2L_2}{N_1L_1}, \quad \text{the ratio by total length.}$$

Other statistical quantities, such as the standard deviation and the coefficient of variation, may be obtained from r(l). If σ is the standard deviation

of lengths about the mean length, L, and S is the root-mean-square deviation about the zero axis L units from the mean,

$$\sigma^2 = S^2 - L^2$$

where $$S^2 = \frac{\int_0^{l_m} l^2 N p(l)dl}{N} = \int_0^{l_m} l^2 p(l)dl.$$

Integrating by parts

$$\int r(l)dl = lr(l) + lq(l)dl$$

$$= lr(l) + \frac{l^2}{2} q(l) + \frac{l^2}{2} p(l)dl.$$

Note:

$$\frac{dr(l)}{dl} = -q(l),$$

$$\frac{dq(l)}{dl} = -p(l).$$

Then $$\int_0^{l_m} r(l)dl = \int_0^{l_m} \frac{l^2}{2} p(l)dl = \frac{S^2}{2}$$

which is the total area under r(l). If then L′/2 is defined as the mean abscissa of r(l), the area under r(l) is LL′/2 and

$$\frac{\sigma^2}{2} = \frac{LL'}{2} - \frac{L^2}{2}.$$

The right side of the equation is equivalent to the area between r(l) and the tangent to r(l) at l = 0. The variance, σ^2, is then twice this area, provided the proper scale is used.

The coefficient of variation

$$\frac{\sigma}{L} = \sqrt{\frac{LL' - L^2}{L^2}}.$$

The tangent to r(l) at l = 0, therefore, divides the area under r(l) into two areas the ratio of which is the square of the coefficient of variation.

On account of symmetry, it is obvious that there would be another fibrogram on the opposite side of the clamp. Since L′/2 is the mean length of the portions of the fibres on one side of the clamp, L′ is the mean length of the fibres clamped. L′ is to be distinguished from L, which is the mean length of the fibres in the population from which the sample was chosen. The clamped fibres do not constitute a representative sample in the ordinary sense, but a sample in which the probability of the presence of a fibre depends upon its length as well as its abundance in the original population. However, the analysis just outlined yields mean lengths for the parent population.

Another type of average length which may be taken from the fibrogram is the upper-half mean. The *upper-half mean* is defined as the mean length of the half-by-weight which contains the larger fibres. This refers to the original population. It is obtained from the fibrogram as follows: FO in Fig. 2 is bisected. A straight line is then drawn through the point of bisection tangent to the fibrograph curve. The abscissa of the point where this tangent crosses the length axis then gives directly the upper-half mean length of the sampled population.

Since, as has been seen, the process of obtaining the coefficient of variation from a fibrogram is somewhat laborious, a new measure of variability of length, known as the *index of length uniformity*, has come into use. It is

defined as the ratio of mean length to upper-half mean length. Since the value of this ratio is less than unity for non-uniform cotton, and becomes unity for completely uniform cotton, it is a satisfactory, easily obtained measure of uniformity. The index of length uniformity is closely correlated with the coefficient of variation in the average fibre distribution, but the two are not exactly equivalent.

Sampling Method

The geometrical properties of the r(l) curve derived from the length-frequency curve appear to be of such practical importance that great care is taken to produce a fibrogram as nearly the equivalent of this curve as possible. This desire for equivalence is accentuated by the extrapolation involved in the use of the tangents. Such requirements not only necessitate an accurate instrument but a good sample.

The sample referred to in the theory could be prepared by clamping a piece of roving along a transverse line and removing all loose fibres. The line would serve as the base line. Such samples were prepared in the early stages of the work. The patience and time required to produce good samples by this method ruled it out as a routine procedure even where paralleled fibres are available. A sufficient number of other methods were tried and discarded to admit of a generalization about the failures: All schemes in which the fibres were first clamped and then combed failed for one of two reasons: (a) if the fibres were securely clamped, too many were broken during the combing process; (b) if they were clamped to allow some slipping, the random distribution was destroyed during combing. Any method for clamping and then combing seemed doomed to failure. Since the fibres generally require both treatments, a successful sampling method must include the simultaneous combing and clamping of the fibres. Fortunately, these operations can be carried on together by two similar combs manipulated so that the fibres on each comb are combed by the other comb. The method seems to be most efficient when the fibres move freely from one comb to the other so that the point on the fibre that lodges between the teeth is a purely chance position. The fibres that extend only a short distance through the comb cannot be engaged properly by the other comb, so that a bias seems to occur here, making the curve unreliable in the region of short fibres. The comb method seems satisfactory because it is simple and rapid and does best under haphazard and relaxed manipulation.

Preparation of the Sample

The combs used for drawing and preparing the sample are each 6¼″ long with number 8 sewing needles spaced .035″ on centers. The needles extend ⅝″ to form the teeth as in a rake.

The problem of selecting a representative sample has been given only preliminary consideration. The accuracy of the instrument will eventually determine how representative the sample must be. It was pointed out previously that the simple selection of a single fibre at a time would give a length-biased sample. There is no length bias in selecting the fibers by groups, and it has been found that the selection of these groups at random over the supply has little or no advantage over their selection on the surface of a freshly broken mass, but it has the disadvantage of being slower and more difficult to manipulate. It has been the practice to open the mass of fibres and select

the groups from the freshly presented surface. Once the fibres are on the combs, the two combs are manipulated symmetrically, so that each comb combs the fibres on the other comb. The manipulation is carried on to give the fibres the best opportunity to distribute themselves at random. The fibre mass is kept fluffy during the mixing process. A relatively small amount of such manipulation reduces a ragged mass of fibres that are obviously neither parallel nor distributed at random to an evenly distributed array of substantially parallel fibres extending from the combs. The mass of fibre behind the teeth need not be smooth, and usually contains the trash of the sample. This part of the sample does not enter the analysis and need cause no concern. Once the fibres are parallel and distributed at random evenly over the two combs, the sample is ready for the fibrograph. The combs with their fibres are placed directly onto the instrument.

The Fibrograph

The present fibrograph operates on the same principle as the fibrograph designed for seed cotton,[3] but it has been so modified that a description of the present instrument seems desirable. A photograph of the instrument is shown in Fig. 3. In the diagrammatical sketch of Fig. 4 A is the analyzing

photovoltaic cell assembly that receives light from a tubular "lumiline" lamp L through two slits S, each 1/8" wide and 6 1/4" long. The balancing photovoltaic cell B receives light from the white reflecting surface R that is placed to receive the most uniform illumination possible. The light passes to B through the iris. The photocell assembly, consisting of eight cell elements connected in parallel, is connected in series with cell B, whose illuminated surface is approximately equal to the illuminated surface of A. A galvanometer G across A indicates zero when the current through A is equal to that through B. The instrument is then said to be balanced. As the cotton samples on combs C are moved upward in front of S, the card holder H with the iris I is moved to vary the light on B so that the galvanometer remains at zero. An adjustable shield between A and L balances the instrument when there is no cotton over the slits and I is placed at its zero point. The pen P moving with the cotton sample, traces the fibrogram on a 3" x 5" glazed card moving with H. When the sample has been completely scanned the trace becomes vertical. Pen P is then released to move down and trace the fibre-

length axis. A stop at the bottom indicates zero length, so that as H is moved back toward the left the number-of-fibres axis is traced. As the end of the axis is reached, the pen is automatically raised, completing the fibrogram. A fibrogram of the $1\frac{3}{16}$" cotton is reproduced to scale in Fig. 5 and is oriented as it appears on the fibrograph. The number-of-fibres axis is the line the pen would trace if the center line of the comb teeth could coincide with the center line of the slits S. This assumes the clamp line to be the center line of the teeth, which might be expected, and seems to be borne out by experiment. The clamp line is probably a diffuse region with its center on the line of teeth.

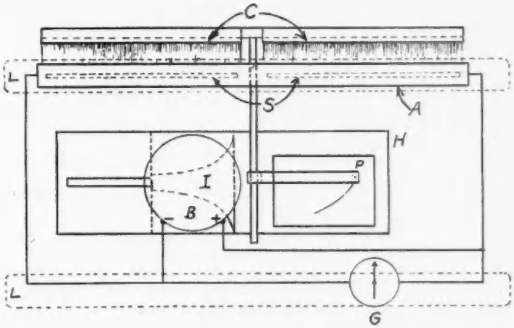
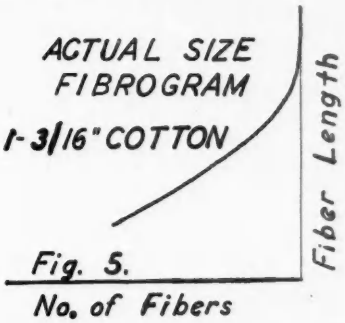


Fig. 4 Diagram of instrument. A, analyzing photovoltaic cell; B, balancing photovoltaic cell; C, cotton samples; S, scanning slit; I, iris; L, tubular lamps; p, pen; H, card holder; G, galvanometer.



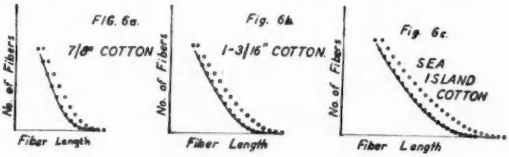
If the fibrogram is to have the properties discussed previously, it is essential that the displacement of the iris be proportional to the number of fibres in front of the slits S. The relation between the intensity of the light transmitted and the amount of cotton in the path depends upon whether the scattered light is included. If the cotton is far from the cell, the scattered light reaching the cell can be neglected, and the relation is logarithmic.

Such an arrangement offered several disadvantages and would be practical only for thin samples. If, however, both the directly transmitted light and the light scattered in the forward direction are measured, the relation $2\beta/I = (\alpha + \beta)e^{\beta n} - (\alpha - \beta)e^{-\beta n}$, suggested by Silberstein [4] applies. I is the total forward light flux, α and β are constants, and n is the number of fibres. Since only the relative number of fibres is important, the determination of α/β is sufficient. The determination of α/β for cotton has been tedious and none too satisfactory, but fortunately the performance of the instrument is rather insensitive to the value of α/β. The shape of the iris has been constructed to cause the light to vary as required.

In order that the Silberstein relation may apply, all of the light emerging in forward directions must be measured. Mechanical difficulties prevent the placing of the photovoltaic cell directly against the cotton. The difficulty is circumvented by conducting the light through a transparent medium $\frac{1}{8}$" thick from the fibres to the cell surface. Total internal reflection causes all of the light that enters the lower edge of the medium to reach the cell surface.

Data and Results

In order to test the instrument and the theory upon which the instrument is based, cottons were analyzed by the fibrograph and by other methods. Attempts to use the Suter-Webb sorter gave such uncertain results with inexperienced operators that it was decided to stretch out the fibres individually on velvet and measure each fibre with a scale. After the measuring of many fibres by this method it was believed that the thicker fibres were not so nearly straight as the long, thin fibres. It was then decided to adopt the still more laborious method of placing the fibres between glass plates and projecting them for measurement. Three cottons in card-sliver form were selected for analysis. About 40 feet of the sliver was laid out and a small wisp taken from 10 points along the sliver. These were mixed and smaller samples drawn. The fibres from the smaller samples were then projected and their length measured with a map measure. The map measure was mounted in a small fixture which held it vertical, the fibre image being focused on an auxiliary screen attached to the top of the fixture directly over the map measure. By means of an arrow to give direction, the fixture could be made to follow the image very accurately. A thin piece of metal, previously measured with a traveling microscope, was placed between the glasses, projected, and measured at various positions in the field to determine the magnification.



The length-frequency data for at least 3000 fibres were obtained for each of the three cottons. Image lengths were grouped in inch intervals (about 1 mm. of actual fibre length) cumulated or integrated twice and plotted (Figs. 6a, 6b, 6c) as open circles on actual fibrograms of the respective cottons. The samples and fibrograms were prepared in a room at 70° C and 65% relative

humidity. All abscissae of the open circles were then reduced by dividing by 1.2 and the data plotted as solid circles.

The table gives the mean and upper-half mean of fibre lengths obtained from absolute measurements (projection) and from the mean of measurements of 140 fibrograms prepared by five operators. The ratio is about 1·19 for all of the results, and explains the good agreement of the solid circles with the fibrogram in Figs. 6a, 6b, 6c. Since there is some difference between operators, the ratio 1·19 must be considered an average value that may not be strictly true for a given operator.

Discussion

It was shown in the case of seed cottons [3] that the fibrograms gave best agreement with measurements of fibres on velvet when the length axes of the fibrograms were increased by a factor of 1.15. It is possible that if those fibres had been measured by the projection method the factor would have been 1.19. It must be remembered that in seed cotton this factor arises primarily from the fibre waviness and tapering of the fibre ends, while in lint cotton there may be some displacement of the base line due to the clamping method in addition to the other factors. If the fibre ends, in order to be clamped, must extend back of the center line of the comb teeth, and if this distance is a constant fraction of the individual fibre length for each fibre, an increase in the above factor would be expected rather than a linear displacement of the zero axis. It should be noted that the effect of tapered fibre ends would be less in lint cotton, since half of the fibres, on the average, would be reversed and the seed end of the fibre is generally less tapered than the tip end.

The results given in the table show that for the three cottons measured the absolute lengths can be obtained fairly accurately by multiplying the apparent (fibrogram) length by the same factor, namely, 1.19.

TABLE 1

Samples of Cotton

	7/8" upland		1 3/16" upland		Sea Island	
Method of measurement	Mean length in 1/32"	Upper half mean length in 1/32"	Mean length in 1/32"	Upper half mean length in 1/32"	Mean length in 1/32"	Upper half mean length in 1/32"
Projection.....	26.6	32.9	33.2	43.9	44.5	61.8
Fibrograph....	22.3	27.4	28.4	36.6	37.4	51.8
Ratio.....	1.19	1.20	1.17	1.20	1.19	1.19

The results from several hundred fibrograms indicate that the standard deviation of mean-length measurements is consistently less than 1/32" for upland cottons. The standard deviation of the upper-half mean length measured with the fibrograph was found by Pope and Ware [5] to be 0.57/32" for several thousand analyses. This error includes that due to sampling, to preparing the sample, to tracing the fibrogram, to drawing the tangents, and to measuring the fibrogram. The average time for a complete analysis is about six minutes.

The use of the fibrograph in the laboratory for routine analysis has raised questions concerning more representative sampling methods, the effect of humidity, the effect of temperature, etc. Studies designed to answer these questions more completely are under way.

Acknowledgments

It is indeed a pleasure to acknowledge indebtedness to Mr. C. A. Mooers, Director of the Agricultural Experiment Station, for his interest in and support of this work; Mr. M. G. Zervigon and Mr. C. S. Harrill, for assistance in the development of the instrument; and Miss Louise McCamy and Miss Elizabeth Cotter for obtaining much of the data used in this paper.

The cotton was furnished by the Brookside Mills, Knoxville, Tenn., and the Bureau of Agricultural Economics, United States Department of Agriculture.

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Further Applications of Fibrograph Curve

IT is believed that the fibrogram, produced by the fibrograph described in the preceding paper, may have useful applications other than the determinations of mean fibre length and fibre length-uniformity. In this paper two applications, one concerning drafting and one concerning yarn structure, will be discussed.

1. *Drafting.*—The fibrogram obtained from a sample of seed cotton [1] is approximately the curve obtained by integrating or cumulating the length-frequency curve. The curve is a familiar one and its properties are known. The fibrogram obtained from a sample whose fibre ends are positioned at random has been shown to be the equivalent of the second successive integral of the length-frequency curve. This curve has received little attention and its properties have not hitherto been carefully worked out. It should be emphasized that this curve is obtained from a sample of fibres arranged exactly as they are during mill fabrication and as they are arranged in the final mill product. It is believed, therefore, that this curve should be more helpful to an understanding of the significance of fibre length than any of the other curves.

It has been shown how various average lengths may be obtained easily from the fibrogram. Since all lengths of fibres are found in the finished product, all lengths should make their contribution to its properties. The significant length, therefore, should be some average value to which all lengths make their contribution. It is desirable now to investigate some of the physical properties of the fibre mass in the light of the fibrogram.

Fibre length is a property that affects the spacing of the drafting rolls in the mill. There is an optimum spacing for a given cotton, and larger or smaller spacings produce imperfections in the yarn. Since the fibrogram of randomly positioned fibres is a curve whose ordinates give the number of fibres extending from the clamp to distances given by the corresponding abscissae, it accurately represents the fibres extending from the nip of the drafting roll. In Fig. 1, AB represents the nip of the first roll and ABLME is the fibrogram for the cotton. A line drawn from the mid-point of AB tangent to BLME would intersect AE near E. The abscissa of this point of

intersection is the upper-half mean length. Although about 25% of the fibres by weight, or possibly 20% by number, are longer than this length, the ordinate to the curve would be about 2% of AB, and therefore only about two fibres in 100 would extend that distance from the roll. Assuming that the second roll is placed at a distance equal to the upper-half mean length, only two fibres in 100 would be in the nip of both sets of rolls at any one time. However, one fibre out of each five (20 out of each 100) passing through the set of rolls would at some time have its ends in the nip of both sets of rolls. The fact that only two fibres instead of 20 out of 100 are in the nip of the two rolls simultaneously indicate that the rolls might be set closer than the maximum length without causing trouble. Regardless of what may happen to the two fibres, the effect on the 100 fibres would be small.

Investigation of the drafting process will be simplified if two pairs of rolls are considered instead of three. To simplify it still further, the two pairs will be assumed at first to have the same speed, and the length distribution of the fibres will be assumed to be the same throughout the fibre mass. In Fig. 1, AB is the nip of the first set and CE of the second set. With the two sets of rolls having the same speed, the shaded area ABLME represents the fibre between AB and CE actually held by the nip of the first set of rolls, and the similar area CENOB the fibre held by the second set. The remaining area BONEML must represent the "floating" fibre that is under neither pair. It should be noted that if every fibre had the length AE the line BLME would be a straight line from B to E and would coincide with BONE, leaving no area for floating fibres, just as it should be. If the roll separation were increased, a small parallelogram would be formed to indicate the floating fibre that would then exist.

In the actual drafting process the second set of rolls runs faster than the first. In the figure it is assumed that the second set of rolls runs at five times the speed of the first and, therefore, there are only one-fifth as many fibres under the second set of rolls, making CD/AB = 1/5. If the drafting is uniform the shaded area BPQDC represents the fibres clamped in the nip of the second set of rolls and is the area BONEC with the ordinates reduced to one-fifth. This, of course, is the condition that would exist if the drafting process were perfectly uniform. When both pairs of rolls had the same speed the "floating" fibres introduced no uncertainty because they would have the same speed as the other fibres. It is necessary now to consider their behavior when both fast-moving and slow-moving fibres are present.

Since the floating fibres are not under the rolls and are not controlled, it will be impossible to describe accurately the behavior of any given fibre. It should be instructive, however, to investigate the probability of certain fibre behavior and the factors involved. If all of the floating fibres moved with the slow fibres until the front end reached the nip of the fast rolls, they would be represented by the area BONEML. At the section KJ, under these conditions, KM would represent the number of slow-moving fibres under the first rolls, MN the number of slow-moving floating fibers, and QJ the number of fast-moving fibres under the fast rolls. If, however, all of the floating fibres moved with the fast-moving fibres just as soon as they left the nip of the slow rolls, the number of floating fibres would be reduced to one-fifth and would be represented by the area BPQDR. At the section KJ, RQ would represent the number of floating fibres instead of MN. It is obvious that the floating fibres are not all going to move either fast or slow. These may be considered limiting conditions that rarely are approached.

It is possible to investigate the probable action of the floating fibre under certain idealized conditions. To do this it will be assumed that a floating fibre moves fast or slow according to whether the majority of the neighboring fibres is moving fast or slow. In Fig. 1 a floating fibre is shown with the length FK. To simplify the figure, FK is one-third AE, making AF = FK = KE. At the position AF, when the fibre just leaves the slow rolls, the slow-moving fibre mass in the region is represented by the shaded area ABLF and the fast-moving fibre mass in the same region by GBP. The floating fibre mass in this same region would not be greater than the area BOL. It is obvious that the particular floating fibre would have more slow-moving neighbors than fast-moving ones even if all the floating fibres represented by BOL should suddenly move fast. According to the assumption made, the particular floating fibre would move with the slow fibres at this position. When the fibre has moved to FK, the controlled slow-moving fibre mass is represented by FLMK and the controlled fast-moving fibre mass by GJQP. At this position the controlled slow-moving fibre mass is still greater than the controlled fast-moving fibre mass, but the floating fibre mass represented by an appreciable fraction of LONM may be sufficiently large to be the deciding factor and make the majority of fibres either fast-moving or slow-moving, according to whether the floating fibres are fast-moving or slow-moving. At the position KE, the controlled fast-moving fibre mass is greater than the controlled slow-moving fibre mass, although not sufficiently greater to assure a majority. The floating fibre mass determines the majority. It would appear from these assumed conditions that the special floating fibre moves slowly at first and most likely becomes a fast-moving fibre before it reaches the nip of the fast rolls.

The point at which the floating fibre changes from slow to fast will be examined still further. At the point of change the slow and fast fibre masses should be equal. Just as soon, however, as one floating fibre changes from slow to fast it changes the conditions surrounding other floating fibres so that the majority of them suddenly change from slow to fast. This effect is cumulative, causing more and more floating fibres to move fast; and once they do move fast they are removed and the floating fibre population decreases to a point at which the controlled slow-moving fibre produces a majority again. When this condition is established, the floating fibres move with the controlled slow-moving fibre mass, increasing the majority so that the floating fibres will continue farther than otherwise before moving fast. When a few start to move fast others follow, causing a large group to move. The net result is that even though the oncoming fibre population has a constant length-frequency distribution and the sliver is perfectly uniform in cross-section, the sliver leaving the drafting rolls must have a varying length-frequency distribution and the sliver must vary in size. The analysis here given would indicate further that there would be a tendency for the short fibres that become floaters to concentrate in the thick places.

It should be emphasized that the periodicity is produced even though the fibres are thoroughly mixed and the sliver is uniform in cross-section, just as a violin string vibrates even though the bow is coated with a perfectly uniform layer of rosin and is moved at uniform speed.

The previous case indicates that the drafting waves depend upon the floating fibre represented by the area BONEML. It is probably true that the greater this area the more pronounced the drafting waves will be. Since this area depends upon the length-uniformity of the fibres and the roll spacing,

the drafting waves should depend upon the same factors. It should be possible, therefore, to produce drafting waves even though all the fibres have the same length, provided the roll spacing is larger than the fibre length.

Thus far it has been assumed that the length-frequency distribution remains constant. If the distribution is variable, or is made variable by the first passage through the drafting rolls, it may or may not be made more variable by further passes. Referring again to Fig. 1, the points L, M, and E would move to the right or left if the average length were increased or decreased. If the roll spacing had been at the optimum length previously it

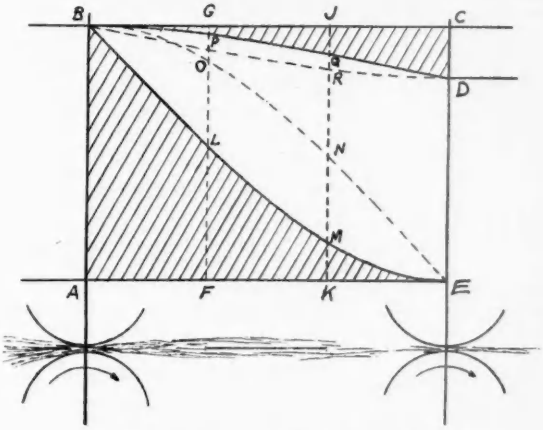

Fig. 1. Diagram of Drafting Rolls.

would not be now. The spacing would be too wide for some sections of the sliver and too narrow for others. At the place where the fibre is short there would be a greater tendency to produce drafting waves, because the area representing the floating fibre mass would be larger. It would appear that non-uniformity of cross-section of sliver would tend to increase with the number of passes through the drafting rolls.

It has been indicated that the drafting waves can be reduced by reducing the proportion of floating fibre. This can be done by reducing the roll spacing or by using fibres that are nearly uniform in length. Both factors tend to reduce the area BONEML. There is a third method by which the periodicity could be reduced. Since the changing area representing the floating fibres becomes more important as the areas representing the slow and the fast fibre becomes equal, it should be possible to increase the draft and thereby decrease CD/AB, so that equality of the areas would occur very near CE. In the figure, area QJCD is greater than area MEK. If the draft is assumed to be 25 instead of 5, the new area QJCD will be only one-fifth as large, and therefore much smaller than MEK. It appears, therefore, that a high-draft process should produce a more nearly uniform product than a low-draft process.

2. *Yarn Structure.*—The fibrogram obtained from lint cotton has been shown to represent the fibres as they occur in sliver and yarn. The fibrogram

should be helpful, therefore, in considering the contribution that fibre length makes to yarn strength. The complete problem of yarn strength is very complicated and not well understood, so that it will be greatly simplified in order to illustrate the possible use of the fibrogram in the problem.

In the first place, the fibres will be assumed to be parallel to the axis of the yarn and pressed together by some external force. It will be assumed also that all fibres have the same strength, size, and effective coefficient of friction. At the bottom of Fig. 2 is represented a piece of yarn that is about to fail at F owing to tension. According to the assumptions made, a fibre would have no tension at its ends and could exert the maximum tension at its middle.

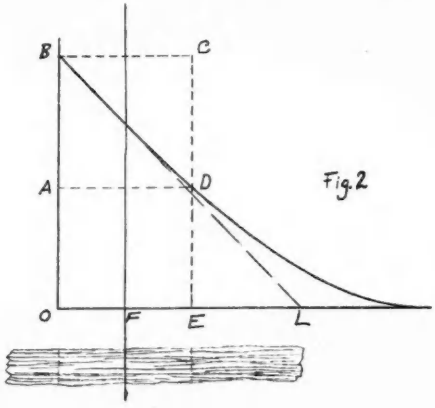

Fig. 2

If the yarn is to fail at F, a fibre extending a sufficient distance on both sides of F would break and one that did not extend a sufficient distance would pull out. It is assumed, therefore, that all fibres extending from O to E will break, while those ending between O and E will pull out. It is easy to obtain from the fibrogram the number that extend this distance. If OB represents all of the fibres in cross-section, then OA represents the number that extend from O, at least as far as E, and hence will break. AB then represents the number of fibres that will pull out without breaking. If, now, the scale of fibre strength is adjusted so that the strength of a single fibre is equal to OE, the area OADE represents the total force that will be exerted by the fibres that eventually break. On the same scale the area ABD represents the total force that will be exerted by the fibers that eventually pull out. The total strength of the yarn is given by the area OBDE, while the total strength of all the fibres in the cross-section is given by the area OBCE. The ratio OBDE/OBCE might be considered some kind of an efficiency factor. Since OL is the mean length of the fibres, all fibre groups having the same mean length should give approximately the same strength, provided all other factors were the same. The less uniform fibres would have a slight advantage, since BD would deviate more from the straight line for the less uniform fibres. This, of course, assumes that they could be processed equally well. A still better criterion would be the mean of all fibres longer than some given length which is shorter

than the slip distance. The tangent to BD between B and D would more nearly approximate BD than would the tangent at B.

This method of representing yarn strength reduces to that given by Kohler [2] when BD is a straight line, which means that there are no fibres shorter than OE. It would seem, from this analysis, that the mean length of the fibres longer than a quarter of an inch would be the best criterion of the fibre length where yarn strength is the quality concerned.

It will be noted that as the average fibre length increases, DE becomes greater and the efficiency ratio increases. The increase is not as much as that found in yarns made from longer fibre. Either the analysis is incorrect or the longer fibres have other properties that make for stronger yarn, such as tensile strength and fineness.

Length is essentially a geometrical property of fibres. Since the fibrogram represents the length property of all of the fibres and represents that property in a manner that is very closely associated with the random arrangement of the fibres, this curve might be expected to represent lucidly the significance of fibre lengths in all states of manufacture, including the finished product. An attempt has been made to point out the possible significance of length in two instances.

Fibre fineness is a factor that also should affect yarn strength, according to the assumptions made. As the fibre gets finer its surface decreases with the square of the diameter. With the same pressure pushing the fibres together, the distance OE would decrease with finer fibre and the efficiency ratio OBDE/OBCE would increase. If the fibres had the same breaking strength per unit cross-section, the yarn made from finer fibres should be stronger provided all other factors remained the same.

The two examples are greatly simplified and are conceded to be only preliminary qualitative representations of the facts.

If, however, this paper shall have a part in stimulating a more qualitative and theoretical approach to these and other problems of the textile industry, it will have achieved one of its purposes.

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Moisture Control: Practical Application in Rayon Slashing

By WILLIAM E. YELLAND *

A Research of U. S. Institute for Textile Research, Inc.

Summary

Results obtained during a study of the sizing of continuous filament bright viscose rayon warps indicated that: (1) Greater uniformity in the regain of sized warps was made possible by means of automatic control of the steam pressure in the dry cans in place of the usual manual control.

(2) A pressure of 7 lbs. to 9 lbs. on six dry cans was sufficient to dry a warp of the type used in these experiments to a regain of 10% at a speed of 40 yards per minute.

(3) The pressure required was determined partly by the amount of moisture left in the warp by the squeeze roll. The type and condition of the blanket on the roll was an important factor.

(4) At pressures below 7 lbs. in the dry cans good control was not obtained due to the clogging of the condensate traps in the steam line.

(5) Automatic control was most effective when there were fewest stops during slashing. Warps must be made carefully in order to prevent stops due to crossed ends, cylinder laps, etc., on the slasher.

Introduction

IN a previous article of this series (*Text. Rsch.*, Aug. 1940) it was pointed out that rayon warps are frequently not dried to a standard or constant regain under ordinary slashing conditions. Experiments showed that warps left the slasher at regains anywhere from 1 to 7%. This constitutes an important variable in size application. It was highly desirable therefore to study this variable and its effect on the weaving properties of the warp and also to determine to what extent the variable could be maintained constant.

Several types of instruments were available for the purpose of controlling regain during slashing. The loan of one of these instruments by a co-operator of the warp sizing project † made it possible to investigate the possibility of automatic control of the regain during sizing.

Twenty-four experimental warps were slashed using the regain control, and also automatic size level and size temperature controls. The warps were

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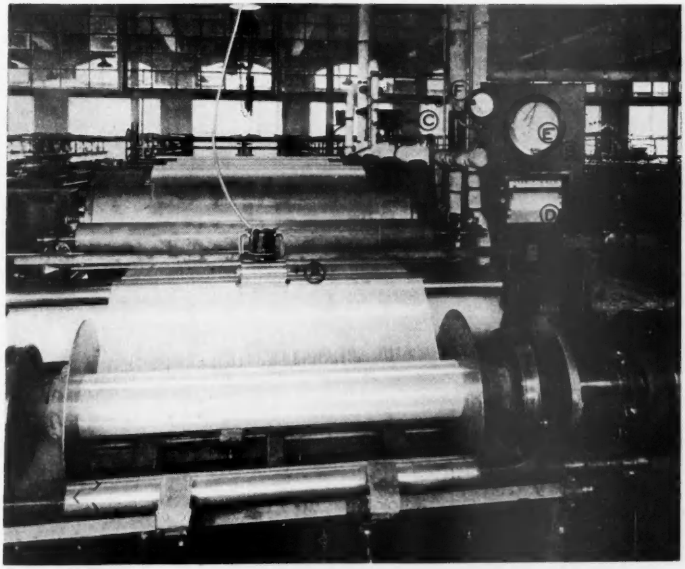
† The Brown Instrument Co.

each 2,300 yards long, and made up of 4,296 ends of 150 denier 40 filament bright viscose for 112 × 68 three-leaf twill. This article presents the data obtained during slashing. The weaving and finishing of the warps will be discussed in subsequent articles.

Type of Instrument Used

The instrument consists essentially of a detecting roll (A), a control panel (B), and a motorized valve (C) on the steam line to the dry cans. The stainless steel detecting roll rides on the warp as the latter passes over the last drag roll at the front of the slasher.



Moisture Control. A, Detecting roll; B, Control panel; C, Motorized valve on steam line; D, Regain record; E, Size record; F, Steam pressure in dry cans.

The warp must be cool when it strikes the detecting roll as calibration of the instrument is made at room temperature and is changed by increase in temperature. In these experiments it was found necessary to cut off the steam in the last can of the slasher for reasons explained below. It was then found that the warp was sufficiently cool when it struck the detecting roll so that no fan or other cooling device was necessary.

The detecting roll measures an electrical property of the warp which is directly related to the regain. The latter may therefore be recorded on a chart on the control panel. When automatic control as well as a record is desired, a pointer in the control panel is set at the regain wanted. The instrument will then endeavor to maintain the regain of the warp as near

this value as possible. This is accomplished through a set of relays and tubes in the control panel which in turn operate a motorized valve on the steam line. When the detecting roll finds the warp moister than the condition for which the indicator is set, the control panel causes the motorized valve on the steam line to open. The steam pressure in the cans rises and the warp is dried more thoroughly. In a similar manner the steam is shut off when the warp is coming off too dry.

Uniformity of Regain

Since the warps were made on the silk system it was not possible to take representative samples from them for regain without interrupting the slashing. The regain was therefore determined by the procedure given in detail in a previous article (*Text. Rsch.*, Aug. 1940). The following tables present the values thus obtained:

TABLE 1

Warp	Average Steam Pressure in Dry Cans During Slashing	Regain of Warp	No. of Stops per Warp
89	9.0 lb.	10.5%	1
93	9.2	11.5	4
94	9.1	10.5	5
97	9.3	8.6	2
Average	9.2	10.3	

It was necessary to change the blanket on the squeeze roll. The effect of this on the drying requirements of the warp is illustrated in Table 2. The first warp (No. 108) sized with the new blanket showed a much higher regain than the following warps. The warps in the following table are di-

TABLE 2

Warp	Average Steam Pressure in Dry Cans During Slashing	Regain of Warp	No. of Stops per Warp
108	7.4 lb.	12.6%	0
110	7.1	9.1	2
100	8.2	9.4	3
102	7.6	9.6	3
99	7.0	9.1	4
109	7.7	10.7	3
90	8.1	9.1	4
91	8.0	9.0	7
95	8.0	9.2	5
98	7.9	10.6	1
107	9.5	10.1	3
Average	7.9 lb.	9.9%	

vided into groups. Each group represents a different type of gelatin size mix.

If warp No. 108 is excluded, on the basis that it was the first warp sized with the new blanket, it will be seen that the regain for this set of warps varies from 9.0% to 10.7%, or a range of 1.7%. The group in Table 1 covered a range of 2.9%. When these values are compared with the results achieved by manual control which were reported in an earlier article (*Text. Rsch.*, Aug. 1940), it is readily seen that it is possible with such a control to dry rayon warps to much more uniform regain than with manual control.

A comparison of Table 1 with Table 2 indicates that the new blanket is giving the warps a harder squeeze than did the old blanket. A steam pressure of approximately 7.9 lb. was sufficient to bring the warp to an average regain of 9.9%, while with the old blanket an average pressure of 9.2 lb. was necessary to dry to an average regain of 10.3%. The new blanket also left less size on the yarn than the old.

One set of warps was run to determine how much moisture could safely be left in the warp.

TABLE 3

Warp	Average Steam Pressure in Dry Cans During Slashing	No. of Dry Cans Used	Regain of Warp	No. of Stops per Warp	By Pass
103	4.7	6	15.8	4	closed
106	5.0	6	14.1	6	open
112	7.9	5	—	2	closed

During the slashing of No. 103 the steam pressure in the cans varied between 2.5 lb. and 7 lb. with average value of about 4.7 lb. The chart record of the regain showed wide fluctuations. It was thought that the condensate trap on the steam return line might not be operating properly at the reduced pressures, thus allowing condensate to collect periodically in the dry cans. A by-pass around the trap was opened and left open during the slashing of warp No. 106. The steam pressure then varied from 3.5 to 6 lb. and the chart record was much improved.

In order to bring the warp to approximately the same regain and yet use higher steam pressures the area of drying surface was cut down by turning off the steam in can No. 6 and drying on five cans instead of six as in No. 112. It was then possible to use an average pressure of 7.9 lb. instead of approximately 5 lb. Because of an error in weighing the unsized beam the regain of warp No. 112 could not be determined as usual. The chart record indicated, however, that it was in the proper range.

Although the slasher * had seven dry cans, the warps were dried on only six or five cans, the last can being allowed to run without steam. This was done deliberately, as previous trial warps had demonstrated that if all seven cans were used a pressure of 2 to 4 lb. was all that was necessary to bring the warp to the desired regain. Higher pressures caused overdrying. At these low pressures close control could not be obtained due to the faulty operation of the condensate traps in the return line as illustrated above.

Thus if the tendency is toward the use of multi-cylinder slashers, lower steam pressures must be used if the warps are not to be grossly overdried. The efficient use of lower steam pressures will necessitate some changes in

* Johnson Machine Co., Paterson, N. J.

the steam and steam return lines. These changes can only be accomplished by much closer co-operation between the machine manufacturers and the mill engineer than has been thought necessary so far.

Although the instrument itself responds very quickly to changes in the moisture content of the warp, the temperature of the dry cans does not change so rapidly because of the large heat capacity of the cans. A sudden increase in speed—say from 20 to 40 yards a minute—will cause a portion of the warp to come off moister than it should be. A sudden decrease in speed will cause local overdrying. Consequently, the control functions most effectively when the speed is maintained as constant as possible and there are few stops during the slashing of a warp. Hence, extra care taken in warping for the prevention of lost and crossed ends will yield better results not only in the warp itself but also in more uniform slashing conditions.

Although the instrument is automatic it can be made to function more effectively by controlling the speed of the slasher manually in starting and stopping, so large changes in speed are not made too suddenly.

Abstracts

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Address, C. H. Clark, Sec., 65 Franklin St., Boston, Mass.

I. Fibres (Synthetic and Natural) and Fibre Analysis

Competitors of Wool. B. H. Wilsdon. *Text. Weekly*, 1939, V. 24, P. 453–4; abs. in *C. A.*, 1940, V. 34, Col. 4579.

The mech. properties (tensile strength, extensibility, elasticity, and rigidity) and H_2O-regain of wool, cotton, silk, viscose, acetate, casein, and nylon fibres are tabulated; they are discussed in relation to the thermal-insulative properties and it is concluded that wool is the superior fibre not likely to be displaced by artificial fibres. (C)

Degumming and Bleaching Decorticated Ramie Fibre (China grass). Mariano P. Ramiro. *Philippine J. Sci.*, 1939, V. 70, P. 411–21; abs. in *C. A.*, 1940, V. 34, Col. 3921–2. (C)

The Effect of Higher Temperatures on the Strength and Stretch of Staple Fibres. Heinrich Lohmann. *Kunst. u. Zell.*, V. 22, P. 64–6 (1940); abs. in *C. A.*, 1940, V. 34, Col. 3503.

The great reduction in wet strength of acetate fibres at higher temps. previously found (*C. A.*, V. 33, Col. 8414) holds true only when measured by an app. in which the load increases uniformly. This effect is not observed with an app. in which the extension is uniformly increased. In practice the second type of stretch is more important, as during laundering; it is therefore not necessary to exercise such caution with regard to increasing the temp. (C)

THE MECHANICAL PROPERTIES OF STRETCHED ACETATE RAYON. Heinrich Lohmann. *Angew. Chem.*, 1940, V. 53, P. 107–9; abs. in *C. A.*, 1940, V. 34, Col. 4579.

With increasing degree of orientation the tensile strength of acetylcellulose fibres increases greatly, while elongation, transverse strength and knot strength decrease accordingly. A higher degree of polymerization has favorable effects upon both tensile and transverse strength. An optimum degree of orientation therefore exists for each degree of polymerization. 63 references and exptl. data are given. (C)

PROTEIN FIBRES: PRODUCTION. W. Machu. *Zellwolle, Kunstseide, Seide*, 1940, V. 45, P. 5–9, 37–38; abs. in *J. T. I.*, May 1940, P. A236.

A review of German, Austrian, Swiss, British, American and French patents relating to the production of fibres from proteins and other materials of animal origin. (C)

TECHNICAL SPECIFICATIONS FOR CASEIN FOR THE PRODUCTION OF ARTIFICIAL WOOL. P. Dyachenko. *Molochno-Maslodel'naya Prom.*, V. 9, No. 6, P. 9–14 (1939); *Chimie & industrie*, V. 43, P. 62; abs. in *C. A.*, 1940, V. 34, Col. 3503.

Only acid-pptd. casein is suitable for the manuf. of artificial wool, lactic and sulfuric caseins giving best results. It must have the following characteristics: H_2O less than 12%, ash less than 3% (less than 4% with sulfuric casein), fat less than 1.69%, acidity less than 60° T., N (via Kjeldahl) not less than 15% on the dry basis, uniform white or cream color, absence of impurities and musty odor. (C)

X-RAY STUDY OF THE ORIENTATION OF ARTIFICIAL FIBRE. V. A. Kargin and N. V. Mikhailov. *Acta Physicochim., U. S. S. R.*, 1939, V. 11, 343–60 (in English); abs. in *C. A.*, 1940, V. 34, Col. 2607.

Exptl. data on the strength and percentage elongation of wet and dry samples of cuprammonium rayon and viscose rayon variously prepd. and treated are given. In contrast to the theory of Mark and Meyer (*C. A.*, *23*, 1263), the authors hold, on the basis of these data, that the true equil. state is one in which the chain aggregates are in a more or less disordered arrangement, and that the elongation-approach to a true crystal is an unstable state. Highly swollen gelatin contg. only 2% α-cellulose shows 2 to 3-fold elongation and, like rubber, almost instantaneous shrinking. (C)

II. YARNS AND FABRICS

ACETATE RAYON WARPS: SIZING. *Leipz. Monats. Text. Ind.*, 1940, V. 55, P. 9–10; abs. in *J. T. I.*, May 1940, P. A242.

Difficulties arising in the sizing of acetate rayon warps and faults in woven fabrics which have been traced to unsatisfactory sizing are discussed. (C)

CARDING PROCESS WITH LONG STAPLE SYNTHETICS. Jesse Withington. *Text Age*, July 1940, P. 30–33. (C)

CRÊPING OF CLOTHS. Joseph Riere. *Teintex*, 1940, V. 5, P. 21–8; abs. in *C. A.*, 1940, V. 34, Col. 3098.

A historical discussion of crêping, which covers many patents and formulas, is followed by some industrial applications. Prepn. of bath, impregnation, choice of catalyst, drying, and polymerization are discussed. Pictures and drawings of the equipment are included. *Ibid.* P. 66–70. The effect of various crêping processes on 217 dyes is discussed and a list of the changes of shade produced is given. Means of measuring crêping are given and pictures of app. included. (C)

FINE COUNTS: SPINNING ON RING FRAMES. (1) W. M. *Textile Recorder*, 1939, V. 57, No. 678, P. 18–22. (2) R. A. H. Leittretter. *Klepzig's Textil-Z.*, 1940, V. 43, P. 243–246; abs. in *J. T. I.*, May 1940, P. A239.

(1) A study of practical considerations to be taken into account when spinning fine yarns on the ring frame. (2) The author points out the advantages of ring spinning, discusses the adaptation of ring frames for the production of fine counts, suitable high draft systems, the best types of spindles, thread guides, etc., and criticises and compares with modern Continental practices some of the recommendations made in (1). (C)

A METHOD FOR PROMOTING THE REMOVAL OF MINERAL OIL FROM WOOL BY EMULSIFICATION. J. B. Speakman and T. S. Wang. *J. Soc. Dyers Col.*, June 1940, P. 259–261.

In previous papers, it has been shown that the difficulty of removing mineral oil from wool by emulsification with soap and soda may be minimized by adding a small percentage of oleyl alcohol to the oil. The alcohol facilitates scouring by reducing the oil-water interfacial tension without causing too great an increase in adhesion. Although more effective than oleyl alcohol in reducing oil-water interfacial tension, oleic acid is not so successful as the alcohol in promoting scouring, because it is converted into soap by the alkaline scouring agent and dissolves in the water. Thereafter, scouring consists simply in the emulsification of mineral oil with soap. It has now been shown that if a neutral detergent is used instead of soap and soda, the oleic acid is retained by the mineral oil during scouring, with the result that mineral oil-oleic acid mixtures containing 15–20% of oleic acid can be scoured with great ease. Besides being satisfactory as regards scouring, such a mixture is capable of fulfilling the requirements of the Insurance Companies as regards flash point, and is free from the risk of causing spontaneous combustion. Further, by utilizing a water-white mineral oil as the basis of the blend, and selecting a suitable fatty acid, or employing an anti-oxidant in conjunction with acids like oleic acid, the oil would not discolor on exposure to light and air. The mixture of mineral oil and fatty acid should, therefore, be highly successful as a wool lubricant. (C)

MILLING THEORY AND PREPARING ACTION. G. L. Atkinson. *Dyer*, 1940, V. 83, P. 143–144; abs. in *J. T. I.*, May 1940, P. A250.

Reference is made to the milling theories of Schofield (*J. T. I.*, 1938, V. 29, T. 239) and of Justin-Mueller (*J. T. I.*, 1939, A.105). The latter's findings are discussed with regard to the action of the rotary milling machine and of the fulling stocks, the latter aiming at a softening effect and the former the production of cover. The influence of soap and moisture is

discussed. Setting effectively retards the milling action of all types of cloth. (C)

OVER-STRETCHED RAYON YARNS: IRREGULARITY. H. Bach. *Kunstseide u. Zell.*, 1939, V. 21, P. 426–431; 1940, V. 22, P. 12–16; abs. in *J. T. I.*, May 1940, P. A268. (C)

THE OXIDATION OF OIL ON DYED AND UNDYED TOPS. J. B. Speakman and C. N. K. Murthy. *J. Soc. Dyers Col.*, June 1940, P. 252–258.

Among the various factors which affect the rate of oxidation of olive oil is the pH of the wool to which it is applied. On undyed wool, the rate of oxidation first increases and then, above pH 9.5, decreases with rise of pH. The decreased rate of oxidation on alkali-treated wool is due mainly to the anti-oxygenic action of the cysteine side chains (sulphydryl groups) formed as a result of disulphide bond hydrolysis. In practice, however, the pH values of undyed tops are within the range of pH where oil oxidation is most rapid, and it seems likely that some advantage would accrue from the use of neutral detergents in backwashing. To be successful, such detergents should, like soap, form an adsorbed film on the fibres, because of the beneficial effect which such a film is believed to exert in combing and spinning. The excessive oil oxidation which sometimes occurs on tops dyed in oil cannot, however, be referred to the pH of the wool, which was acid in all the cases examined. The cause in such cases was ultimately traced to an exceptionally high iron content of the tops. Iron has a marked pro-oxygenic action and is introduced into the oil by the corrosive action of the acid retained by the wool, when the latter is not sufficiently washed-off or neutralized before being processed on wool textile machinery. Acid dyeings which formerly led to severe oil oxidation were found to be without pro-oxygenic activity when the washing-off process was effective. (C)

PAPER YARN: PRODUCTION. W. Frenzel. *Textilber.*, 1940, V. 21, P. 52–4; abs. in *J. T. I.*, May 1940, P. A239.

Paper yarns are prepared by cutting paper sheets into narrow strips, damping the strips, and twisting them on spinning or doubling machines. The calculation of the metric counts of the strips and yarns is explained. The paper used for the production of paper yarns should have a high moisture absorbing power and good wet strength. The strength of the paper yarn is less than that of the paper strip from which it is prepared but the extensibility of the yarn is higher than that of the paper. The effects of the type of spinning machine used, the manner of distribution of the cellulose fibres in the paper, the nature of the cellulose pulp used for the paper, and other factors are discussed. A table is given showing strengths and extensibilities, moisture absorptions, and resistances due to sizing of various spinning papers. (C)

PIN SETTING IN NOBLE COMBING. S. Kershaw. *J. T. I.*, May 1940, P. P59–66.

Attention is drawn to the differences between the various particulars given in text-books relating to the pinning of Noble comb circles. The figures referred to are copied out by students and others who rarely challenge their correctness, or consider the principles underlying wool combing. New methods of pinning are explained and tabulated, and these offer a challenge to existing methods and can be used as a basis for discussion. (C)

STAPLE FIBRE: EFFECTS OF OILING ON SPINNING PROPERTIES. R. Stoll and F. Kurtz. *Klepzig's Textil-Z.*, 1940, V. 43, P. 207–211; abs. in *J. T. I.*, May 1940, P. A238.

It is pointed out that certain improvements in flexibility and regularity and reduction in electrostatic charging noted as a result of oiling, particularly in the case of a poorly-finished staple fibre, could have been achieved more effectively by a better finishing treatment of the fibre in the course of production. For the qualities of staple fibre now on the market, oiling is not only unnecessary but even to a certain extent disadvantageous but with certain lower quality products some improvement in spinning properties may be produced by oiling. (C)

SUCCESSFUL SIZING. W. W. Wilkinson. *Silk J. & Rayon Wld.*, April 1940, P. 34–5.

Principles which, although they have to some extent been applied unconsciously since the beginning of the sizing process, have been revealed as such only within recent years. In this article, the author considers those principles so far as they affect the selection of sizing ingredients and their association in size mixings. (C)

YARNS: STRENGTH AND EXTENSIBILITY; INFLUENCE OF HUMIDITY ON —. E. Thiemann. *Textilber.*, V. 21, P. 61–4; abs. in *J. T. I.*, May 1940, P. A268. (C)

III. CHEMICAL AND OTHER PROCESSING (NOT OTHERWISE CLASSIFIED)

AZOIC COLORS—IMPROVED FASTNESS TO RUBBING ON PIECE GOODS. E. R. Wiltshire. *J. Soc. Dyers Col.*, June 1940, P. 245–252.

An outline of the recommended dyeing process is as follows: (1) Efficient preliminary scouring of the material. (2) Use of a Brenthol of high substantivity and exhausting with common salt. (3) Dissolving the Brenthol in presence of Lissapol LS and Dispersol L. (4) Application of the Brenthol on the jig, starting at b.p., and continuing in a cooling bath. (5) Intermediate drying between impregnation and development. (6) Development on the pad. (7) Acid rinsing after development. (8) Soaping in a high concentration of Lissapol LS and soap without soda ash. (9) Efficient final rinsing. (C)

BLEACHING LANITAL-RAYON MIXTURE FABRICS. C. Boggero. *L'Industrie Textile*, 1939, V. 56, P. 568; abs. in *J. T. I.*, May 1940, P. A251.

The fabric, previously cleansed in a lukewarm state with a neutral detergent, is left overnight at 35–40° C. in a hydrogen peroxide bath (2–3 vol.) at pH 7.6–7.8. It is then rinsed, treated in a sodium hydrosulphite bath (3–4 g. per litre), slightly acidified, rinsed, and dried at a moderate temperature. (C)

"CONVEYOR" PIECE DYEING MACHINE. E. V. Giles. *Text. Mfr.*, 1940, V. 66, P. 107, 112; abs. in *J. T. I.*, May 1940, P. A252.

Illustrations are given of a dyeing machine for delicate worsted fabrics in which the customary winch and breast rollers are replaced by two rollers or sets of wheels carrying an endless travelling conveyor. This is claimed to prevent crease marks. (C)

DENSITY OF WOOL IN RELATION TO ACID DYEING. P. M. Heertjes. *Atti X° congr. intern. chim.*, 1939, V. 4, P. 755–62; abs. in *C.A.*, 1940, V. 34, Col. 3094.

The dyeing process of wool by acid dyes is studied. By means of gas-volumetric d. detns. using He gas as an imbibition medium, it has been shown that the dying of wool with acid dyes is a chem. process by which the dye penetrates, at least partly, into the micelle substance. By the acid dye process an extra increase of vol. of the micelle substance is caused. This extra increase of vol. is directly proportional to the size of the dye mol., however, on the understanding that only mols. above a certain size will commence to cause the said increase of vol. This can be explained by the peculiar structure of the wool keratin. (C)

DYEING OF ARTIFICIAL FIBRES. Earnest Meili. *Text. Bull.*, 1940, V. 58, P. 10–13, 34. (C)

DYEING OF LANITAL. *Deut. Farber-Ztg.*, 1940, V. 76, P. 65; abs. in *J. T. I.*, May 1940, P. A253.

Lanital absorbs acid dyestuffs at 20° C., the maximum absorption being reached at 80°. Dyeings at 40–60° on Lanital come up as strong as on wool at 100°. With acid dyestuffs, formic acid (3%) is added to the bath at 70°, the goods added and heated to 90° for ½ hr. With chrome dyestuffs, the fibre is first boiled for ½ hr. with bichromate (1%) and acetic acid (3%). Lanital also has a good affinity for direct cotton dyestuffs. Fastness to washing is usually lower than on wool, fastness to light and discharging power being the same on both fibres. (C)

DYEING LANITAL MIXTURE FABRICS. *Der Textil. u. Col.*, 1939, V. 20, P. 113–115; abs. in *J. T. I.*, May 1940, P. A252.

Fastness to light and washing is improved by using minimum amounts of acid in the dyebath. Faster dyeings are secured by using, instead of the free acids, their ammonium salts. The wet fastness properties are reduced by excessive boiling, apart from the bad effect on the fibre itself. Dyestuffs of the Supramine and Palatine types are recommended. In the latter case, the material is entered at 60° C. in a bath containing 6% sulphuric acid and 4% dyestuff, the temperature raised to 100° C. and the bath kept for ¾–1 hour at a moderate boil. Care must be taken that the fibres do not form a compact mass. In drying, a temperature of 70° should not be exceeded. If a Lanital mixture fabric contains 40–50% wool, it is treated as a wool fabric. (C)

DYED MATERIALS: STRIPPING. J. Riere. *Teintex*, 1939, V. 4, P. 660–668; abs. in *J. T. I.*, May 1940, P. A252.

Procedures for the removal of the various types of dyes from cotton and linen, rayon and wool are described and the stripping agents and auxiliary agents used for this purpose are discussed. (C)

FIREPROOFING OF FABRICS. Louis Diserens. *Teintex*, 1939, V. 4, P. 671–7; abs. in *C. A.*, 1940, V. 34, Col. 2183.

Discusses the use of NaCl, KCl, $AlBr_3$, $CaSo_4$, $MgSO_4$, $(NH_4)_2SO_4$, $ZnSO_4$, KNO_3, $Ca(NO_3)_2$, Na_3PO_4, K_3PO_4, $Ca_3(PO_4)_2$, $Mg_3(PO_4)_2$, $Na\text{-}HPO_4$, $(NH_4)_2HPO_4$, $(NH_4)_3PO_4$, $MgNH_4PO_4$, Na_2CO_3, Na, Zn and Al borates, sili-

cates, Al(OH) and Na stannate. Details are furnished for the use of sol. salts, insol. salts formed in the fibres, use of chlorinated rubber, and the use of cellulose esters and synthetic resins. (C)

FOAM-PREVENTING AGENT. *Deut. Farber-Ztg.*, 1940, V. 76, P. 89; abs. in *J. T. I.*, May 1940, P. A256.

Etingal A (I.G.), for use in dyeing and finishing liquors and in print-pastes, prevents foam formation even in the presence of strongly-foaming auxiliary agents, and thus obviates difficulties such as floating of the goods. (C)

HYDROPHOBING: WHAT IS IT? Carl-Heinz Fischer. *Färber u. Chemischreiniger*, 1939, P. 46–7; *Chem. Zentr.*, 1939, V. II, P. 561–2; abs. in *C. A.*, 1940, V. 34, Col. 2182.

Hydrophobing is the elimination in the cellulose mol. of the OH groups which produce swelling. Well-hydrophobed textiles should be stable to wet and chem. washing and dyeing. The Persistol process of the I. G. Farbenind. is described. (C)

NAVY BLUE STAPLE FIBRE AND RAYON FABRICS: DYEING. *Textilber.*, 1940, V. 21, P. 29–30; abs. in *J. T. I.*, April 1940, P. A188.

Navy blue dyeings of good fastness to light, washing and rubbing, and on which white and colored discharges can readily be obtained, are produced on staple fibre and rayon fabrics by means of the combination Napthol AS-Fast dark blue salt R. Procedures for the production of navy blue and lighter blue dyeings and white and colored discharges are described. (C)

"PAINTED" PRINTING PROCESS. Metzl. *Mell. Textilber.*, 1939, V. 20, P. 287; abs. in *C. A.*, 1940, V. 34, Col. 3095.

A new style of textile printing, especially suitable for rayon and silk fabrics, is described. It allows the production of an appearance closely resembling that of a H_2O- or oil-painting by printing a lustrous fabric with a matt pattern before or after printing with a multicolor or 2-tone pattern with the aid of acid, basic, and vat dyes. Recipes of printing pastes for obtaining the matt and color effects are given. (C)

PEROXIDE BLEACHING LIQUORS: DECOMPOSITION AND STABILIZING. *Textilber.*, 1940, V. 21, P. 31–2; abs. in *J. T. I.*, April 1940, P. A187.

The catalytic action of alkalis, peroxidases, and salts and oxides of copper, iron and other metals on the decomposition of hydrogen peroxide bleaching solutions and the stabilising effects of acids, phosphates, compounds of magnesium, calcium and tin, and catalyst poisons such as alcohols, ketones, uric acid, carbon monoxide, hydroxylamine and various other organic compounds are discussed and patented stabilising preparations are mentioned. (C)

PRINTING PASTE THICKENERS: SWELLING AND SOLUTION OF DYES IN. H. Gerber. *Textilber.*, 1940, V. 21, P. 76–9; abs. in *J. T. I.*, May 1940, P. A254.

Printing paste thickeners absorb moisture and swell in the steaming process. Part of the moisture absorbed is then given up as a solvent to the dye and the dye solution formed diffuses through the capillary structure

of the thickening agent to the fibre. The intensity of the print depends on the proportion of absorbed moisture used in this way. An indication of this proportion can be obtained from a study of the rise of solutions in strips of filter paper. When a strip dips into an aqueous solution of a dye the solution rises in the strip and at the beginning of the diffusion a zone of pure solvent is observed above the zone of dye solution on the paper. Similar results are observed with thickening agents. The results of measurements of the breadth of the water zone after one hour and of the total diffusion after a period of 24 hours with various dyes in Plexileim, Sichelleim, Hortol S, tragacanth, and various gum and starch thickeners are discussed and it is shown how the suitability of the various thickeners can be determined by such measurements. In general tragacanth and starch give the greatest heights of rise and broadest water zones and the best results in printing. (C)

Rayon and Staple Fibre: Structure and Dyeing Properties. W. Weltzien and K. Windeck-Schulze. *Zellwolle, Kunstseide, Seide,* 1939, V. 44, P. 399–404; abs. in *J. T. I.,* April 1940, P. A191.

The problem of the uneven dyeing of viscose rayon with certain dyes is discussed and it is pointed out that the same dyes give even dyeings on cuprammonium rayon and hence it is not a question of even and uneven dyes, but rather of even and uneven dyeing dye/fibre systems. In a study of this problem measurements were made of the velocities at which Brilliant Benzo Blue 6B is taken up by viscose and cuprammonium rayons, and the speed at which it is washed out from the same, and the penetration of the dye into the fibre and the influence of chemical and mechanical pretreatments of the fibre were also studied. In both the adsorption and washing out processes clear differences are observed between ordinary viscose rayon and staple fibre products on the one hand and cuprammonium rayon and staple fibre and viscose products obtained by spinning processes similar to the cuprammonium stretch spinning process on the other hand. The cuprammonium type fibres show the higher adsorption and washing out speeds and the more level dyeings. Photomicrographs of cross-sections of the dyed fibres and observations of the effects of particle size indicate that the particle size of substantive dyes is not the determining factor for penetration. Differences in penetration observed between the ordinary viscose fibres and the cuprammonium type fibres appear to be due to the presence in the former of certain outer layers which have a checking action on the penetration of the dye, probably on account of electrostatic charging and also of denser packing. Under certain dyeing conditions edge effects can be observed in both viscose and cuprammonium fibres, but considerable differences between the two types are apparent. The checking outer layers of ordinary viscose fibres can be broken down by treatment with caustic soda or by intensive mechanical treatment after which the dyeing properties of the fibres approximate to those of cuprammonium fibres and viscose fibres produced by analogous spinning processes. The differences in dyeing properties of the two types of fibre can therefore be traced to differences in structure resulting at least in part from differences in the spinning processes. (C)

Printing Phosphorescent Effects on Viscose Rayon Cloth. Raffaele Sansone. *Silk J. & Rayon Wld.,* October 1939, P. 14–40. (C)

RAYON FABRIC: DYEING AND FINISHING; EFFECTS OF ACIDS. C. H. Fischer. *Zellwolle*, 1939, V. 5, P. 121–3, 161–2, 198–9, 310–4; abs. in *J. T. I.*, April 1940, P. A188.

The effects of acids on textile fibres are discussed and a study is made of carbonizing, acid fulling, Indigosol developing, chlorinating, scrooping, water-proofing, dyeing and scouring processes, dye bath additions, the rinsing of acid-treated goods, and neutralization after-treatments in relation to the treatment of goods containing rayon or staple fibre, especially in mixtures with wool. The influence of acid concentration is examined, tables are given showing losses in strength and extensibility of viscose and cuprammonium fibres as a result of acid treatments, the damage caused by acid residues in fabrics is pointed out, and the need for more care in the treatment of goods containing rayon and staple fibre with acids is emphasized. (C)

RAYON WASTES: HOW SHOULD—BE BLEACHED? K. Liebsch. *Monatschr. Textil-Ind.*, 1939, V. 54, P. 208–9; abs. in *C. A.*, 1940, V. 34, Col. 1493.

The wastes are first pretreated with Na perborate and Na silicate at 60–70° and then bleached with Ca hypochlorite. The procedure is described in detail. (C)

SILK WEIGHTING: MODERN PRACTICE IN. "Practicus." *Silk J. & Rayon Wld.*, August 1939, P. 19–20. (C)

SILK-ACETATE RAYON MIXTURES: DEGUMMING. W. Bachofner and F. B. Dambacher. *Zellwolle, Kunstseide, Seide*, 1940, V. 45, P. 10; abs. in *J. T. I.*, April 1940, P. A187.

Various methods for the degumming of silk-acetate rayon mixtures are examined in regard to efficiency of degumming and action on acetate rayon and it is pointed out that in the treatment of such mixtures temperatures above 70° and pH values above 9 should be avoided. The use of products which, in contrast to soap, show decreases in degumming effect and also in power of attacking acetate rayon with decrease in temperature is recommended. (C)

SYNTHETIC RESINS: PENETRATION INTO FIBRES. Fritz Ohl. *Kunstseide u. Zellwolle*, 1940, V. 23, P. 32–34; abs. in *J. T. I.*, May 1940, P. A255.

The author remarks that one of the newest and most popular finishes to staple fibre makes the material waterproof and water-repellant and suggests that this effect is produced by blocking the cellulose molecule side chains. The possibility of using synthetic resins for this purpose is examined. Simple experiments in fibre impregnation with phenol and phthalic acid-formaldehyde resins are described and photomicrographs are reproduced showing the cross-sections of fibres penetrated to different degrees. (C)

IV. RESEARCH METHODS AND APPARATUS

COLOR TEST FOR THE DETECTION OF BLEACHED WOOLEN FIBRES. J. Pinte. *Atti X° congr. intern. chim.*, 1939, V. 4, P. 785–8. Abs. in *C. A.*, 1940, V. 34, Col. 3095.

The bleaching of woolen fibres leaves residual reaction products on the fibres. These products are produced by the action of oxygen on the pro-

teids. They are difficultly removed by washing and they can be detected by treatment with KI and starch in presence of HCl. Woolen fibres are macerated in distd. water which has been repeatedly boiled to remove dissolved oxygen and gasses. A mix of a soln. of KI, starch paste and dil. HCl is slowly added and allowed to diffuse without agitation. Bleached woolen fibres produce a violet color which turns blue on standing. This reaction is sp. for wool and silk and will be pos. only if bleached fibres are present. Chlorinated wool will give a neg. test. The residual quantity of combined oxygen can be estd. quantitatively. A weighed quantity of woolen fibres is macerated with distd. water and is treated with NaI, $MnCl_2$, dil. HCl and starch paste. The reaction mix is titrated with $Na_2S_2O_3$. The end point is the disappearance of the blue color. A blank is run on unbleached fibres. The difference in titration corresponds to the residual oxygen on the fibres. (C)

DETERMINATION OF LANITAL IN THE MIXED FABRICS WITH NATURAL WOOL. G. Chessa. *Chim. ind. agr. biol.*, 1940, V. 16, P. 37; abs. in *C. A.*, 1940, V. 34, Col. 3096.

Wash 1 g. of sample with alc.-Et_2O, then with H_2O, dry at 110–20°, treat with 50 cc. of a reagent formed from 100 cc. of 28° Bé. glycerol and 15 cc. of 10% HCl, and boil under reflux for exactly 3 min. Dil. the soln. with 50% alc., filter, wash the insol. matter, dry at 110–20° and weigh. The reagent dissolves lanital but not natural wool. (C)

THE EFFECT OF SODIUM BICARBONATE ON THE BLEACHING OF LINEN. B. V. Moryganov and L. V. Gur'yanov. *L'no-Pen'ko-Dzhutovaya Prom.*, 1938, No. 10, P. 35–42; *Khim. Referat. Zhur.*, V. 2, No. 2, P. 116 (1939); cf. *C. A.*, V. 33, Col. 9657; abs. in *C. A.*, 1940, V. 34, Col. 3099.

The bleaching process was controlled by the amt. of Cl_2 used, by the breaking strength of the cloth, by the elongation on breaking, by the capillarity, by the degree of whiteness and by the stability of the white color to steaming. The addn. of $NaHCO_3$ in the first treatment increases the whiteness of the cloth 3–4% and reduces the time of the treatment from 3 to 1 hr. The treatment should be performed at a 4 g./l. concn. of the active Cl with addns. of $NaCO_3$ (0.5 mol./mol. of NaOCl) at 20–30° for 1 hr. The second treatment of the cloth should be performed at a concn. of NaOCl corresponding to 3 g./l. of the active Cl with an addn. of $NaHCO_3$ (1.5 mol./mol. of NaOCl) and should last for not more than 1 hr. The whiteness of the cloth is thereby increased 1.2%. Expts. performed under production conditions confirmed the lab. results. A bleaching of flax textiles in a continuous process with an addn. of $NaHCO_3$ into the bleaching soln. was successfully obtained. (C)

THE EXAMINATION OF DAMAGED COTTON BY THE CONGO RED TEST: FURTHER DEVELOPMENTS AND APPLICATIONS. Gladys G. Clegg. *J. T. I.*, May 1940, P. T49–68.

Since the publication in 1926 of a description of the Congo Red staining method (*J. T. I.*, 1926, *17*, T396–404) the test has been in constant use at the Shirley Institute. Further observations have been made on the appearance of damaged and treated fibres stained by this method, and results and details of the technique, as described by the author and illustrated with

excellent photomicrographs, should enable the method to be used by many engaged in textile research, particularly those who are called upon to differentiate between the various types of tendering occurring in cotton yarns and cloths. (C)

FIBRE MIXTURES: ANALYSIS. A. Schaeffer. *Textilber.*, 1940, V. 21, P. 65–70; abs. in *J. T. I.*, May 1940, P. A265.

Details are given of procedures for the qualitative analysis of mixtures of the various types of textile fibres and the quantitative analysis of wool-cotton, wool-staple fibre (rayon), wool-cotton-staple fibre, wool-casein fibre, wool-casein fibre-staple fibre mixtures, mixture yarns containing cellulose acetate rayon, and mixture yarns containing silk. (C)

FLUIDITY OF COTTON IN DIMETHYLDIBENZYLAMMONIUM HYDROXIDE—MEASURE OF COTTON DEGRADATION. W. Walker Russell and Norman T. Woodberry. *Ind. Eng. Chem., Anal. Ed.*, V. 12, 151–4 (1940); abs. in *C. A.*, 1940, V. 34, Col. 3075.

Different samples of bleached cotton cellulose (I) were found to dissolve readily in 0.5% concn. in the optimum diln. 1.96 $\pm$ 0.01 N dimethyldibenzylammonium hydroxide (Triton F) (II) to produce solns. whose fluidities (or viscosities) are a measure of the extent to which the I has been degraded. For the I studied the II fluidities are very nearly a tenth, and the II sp. viscosities very nearly twice the corresponding cuprammonium hydroxide values. The II method is simpler, as it can be carried out in the air and light, and is faster. (C)

A MACHINE FOR TESTING THE FASTNESS TO RUBBING OF DYED MATERIALS. D. A. Derrett-Smith and H. B. Bradley. *J. Soc. Dyers Col.*, June 1940, P. 261–265.

A description is given of a simple machine which has been designed for testing the fastness to rubbing of dyed yarns and fabrics. A selection of dyeings has been tested, and the method of using the machine and the interpretation of the results are described. (C)

REFRACTIVE INDEXES OF TEXTILE FIBRES: DOUBLE VARIATION METHOD FOR THEIR DETERMINATION. Kenneth R. Fox. *Text. Rsch.*, 1939, V. 10, P. 79–93.

The method and app. employed to secure a more precise and convenient method of measuring the refractive indexes of individual textile fibres are outlined. Refractive indexes of standard immersion fluids are shown, also curves giving temp. increase vs. heater scale reading, the effect of temp. on refractive indexes, the effect of wave length on them, and a sample of the data taken in test detns. and a measure of the dispersion in each table. (C)

SHIRLEY MOISTURE METER. *Text. Wkly.*, 1939, V. 24, P. 745–8; abs. in *J. T. I.*, Feb. 1940, P. A98.

The Shirley Moisture Meter comprises an electrode system for measuring the electrical resistance of a sample of cotton and an indicating system which indicates the moisture regain of the sample directly. The electrode system consists of a cylindrical stainless steel core surrounded by

ebonite and enclosed in a nickel sheath. It is pressed on to the sample with a force of about 45 lb. wt. A mechanical constant pressure device has been designed in order to relieve the fatigue to a routine tester. The electrical resistance measured is that of the cotton bridging the gap between the inner core and the outer sheath of the electrode system. An amplifying valve is employed to build up the current and make possible the use of Record "Cirscale" indicators which have easily read circular scales and give accurate readings over clearly marked dials. The apparatus is portable and may be worked from any ordinary A.C. electrical supply. It can be used for measurements on raw cotton and on grey cotton yarns in any form of package over a range of from 4.5 to 15% regain. With the aid of conversion tables the instrument can also be used for testing bleached cotton and yarn, cotton cloths in various states of finish, and also various other textile materials with the exception of silk or acetate rayon. Oven and meter tests on a large number of cottons and yarns have demonstrated the essential accuracy of the Moisture Meter. (C)

SISAL FIBRE: PROPERTIES. C. A. Gehlsen. *Inter. Rev. Agric.*, 1939, V. 30, P. 424–31T; abs. in *J. T. I.*, Mar. 1940, P. A149. (C)

SLIVERS AND ROVINGS: TESTING. *Revue Textile*, 1939, V. 37, P. 489–505; abs. in *J. T. I.*, Mar. 1940, P. A128.

The value of tests of slivers and rovings for control purposes is discussed and the method of determining regularity by weighing successive short lengths is briefly described. The Lipowsky regularity tester, the Litty roller setting determinator and device for determining regularity of resistance to drafting, the Saco-Lowell sliver tester, and the Toenniessen regularity tester are described and shown in diagrams and photographs. Typical results obtained by the weighing method and records obtained with the various testing devices are given and discussed. (C)

SPECTROGRAPHIC IDENTIFICATION OF IMPURITIES. Erwin J. Saxl. *Rayon Text. Mo.*, Sept. 1939, P. 75–6.

The advantages of spectrographic analysis as they relate to textile work are given as follows: The extraordinary sensitivity of this method of investigation; not only is the qualitative identification possible, but also the quantitative determination as it relates to very small quantities of impurities present; the minute amount of materials necessary for investigation; the speed of the method. (C)

STAPLE FIBRE: MECHANICAL-TECHNOLOGICAL PROPERTIES. K. Breuer. *Kunstseide*, 1939, V. 21, P. 202–8, 242–6; abs. *in J. T. I.*, Dec. 1939, P. A786.

Apparatus and procedures for the determination of the twisting capacity and the dry and wet breaking twists of staple fibres are described and results obtained for various staple fibres, including Vistra, Phrix, Cuprama, Rhodia, Artilana, and Lanusa products, and for wool, are given and discussed. Strength and extensibility tests and the dependence of the results on the conditions of testing and on fibre fineness are studied. Dry and wet strength and extensibility data are given for various wool-type

staple fibres and irregularities in these properties and their causes are discussed. (C)

V. Pure Science, Economics and Misc.

Fibrous Triacetyl Cellulose: Heterogeneous Hydrolysis of—by Acid and the Acetone Solubility of the Partially Hydrolyzed Product. I. Sakurada, I. Tukahara, and T. Morita. *J. Soc. Chem. Ind., Japan*, Aug. 1939, V. 42, P. 252B–55B; abs. in *Eastman Kodak Abs. Bull.*, Jan. 1940, P. 43–4. (S)

Hydrogen Peroxide: Evaluation. S. M. Tritton. *Analyst*, 1939, V. 64, P. 469–74; abs. in *J. T. I.*, Oct. 1939, P. A667.

In connection with an inquiry into the effect of catalase in causing the decomposition of hydrogen peroxide, tests have been made on reagents for evaluating free or stabilized solutions. Titanous chloride is not suitable, but titration with permanganate or titration of the iodine liberated from K iodide are equally satisfactory. (C)

Kinetics of Chain Polymerization: The Thermal Polymerization of Styrene in Different Solvents. G. V. Schulz, A. Dinglinger, and E. Husemann. *Z. Physikal. Chem.*, Aug. 1939, V. 43B, No. 6, P. 385–408; abs. in *Eastman Kodak Abs. Bull.*, Dec. 1939, P. 661. (S)

Kinetics of Reaction of Chain-Molecules in Solution. I. Alkaline Saponification of Polyvinyl Acetate. S. Lee and I. Sakurada. *Z. Physikal. Chem.*, July 1939, V. 184, P. 268–72; abs. in *Eastman Kodak Abs. Bull.*, Dec. 1939, P. 661.

The velocity of saponification of polyvinyl acetate (degree of polymerization 280 and 920) was compared with that of monomeric vinyl acetate and of ethyl acetate. In all cases, it was found that not only was the process bimolecular but also that the same velocity constant, heat of activation, collision number, and probability factor were obtained. (S)

Lattices of Native and Hydrate Celluloses: Relation Between the. E. Sauter. *Z. Physikal. Chem.*, July 1939, V. 43, No. 4, P. 294–308; abs. in *Eastman Kodak Abs. Bull.*, Nov. 1939, P. 603.

By redefining the coördinates of the unit cells in terms of the Sponsler and Dore lattices rather than those of the Mark, Meyer, and Andress structures, a new interpretation of the dimorphism of cellulose is given. (S)

Low Temperatures: Automatic Production and Control of. Otto Th. Koritnig. *Zellwolle u. Deut. Kunstseiden-Ztg.*, 1939, V. 5, P. 307–8; abs. in *C. A.*, 1940, V. 34, Col. 1184.

An illustrated discussion of industrial installations for the textile industry. (C)

Molecular Weights, Unimolecular Layers, and the General Structure of Proteins. G. Th. Philippi. *Chem. Weekblad*, 1939, V. 36, P. 266–74 (in English), (through *C. A.*, 1939, V. 33, Col. 5726); abs. in *J. T. I.*, Oct. 1939, P. A677. (C)

OLIVE OIL COMMITTEE: REPORT OF. M. F. Lauro. *Oil & Soap*, 1939, V. 16, P. 171–84 (through *C. A.*, 1939, V. 33, Col. 8431); abs. in *J. T. I.*, Dec. 1939, P. A814.

Two recently devised tests for the detection of teaseed oil in olive oil, the Siebenberg-Hubbard and the Fitelson or so-called government tests were investigated. Data are given in a general report, showing the collaborative results with individual comments. The conclusion is reached that the Fitelson test is by far the easier to perform, the clearer to interpret and is applicable to any type of olive and teaseed oil mixture. The method is recommended for adoption as a tentative method. (C)

OPTICAL ANISOTROPY AND THE STRUCTURE OF CELLULOSIC SHEET MATERIALS. J. Spence. *J. Phys. Chem.*, Oct. 1939, V. 43, P. 865–79, Communication No. 700; abs. in *Eastman Kodak Abs. Bull.*, Dec. 1939, P. 666.

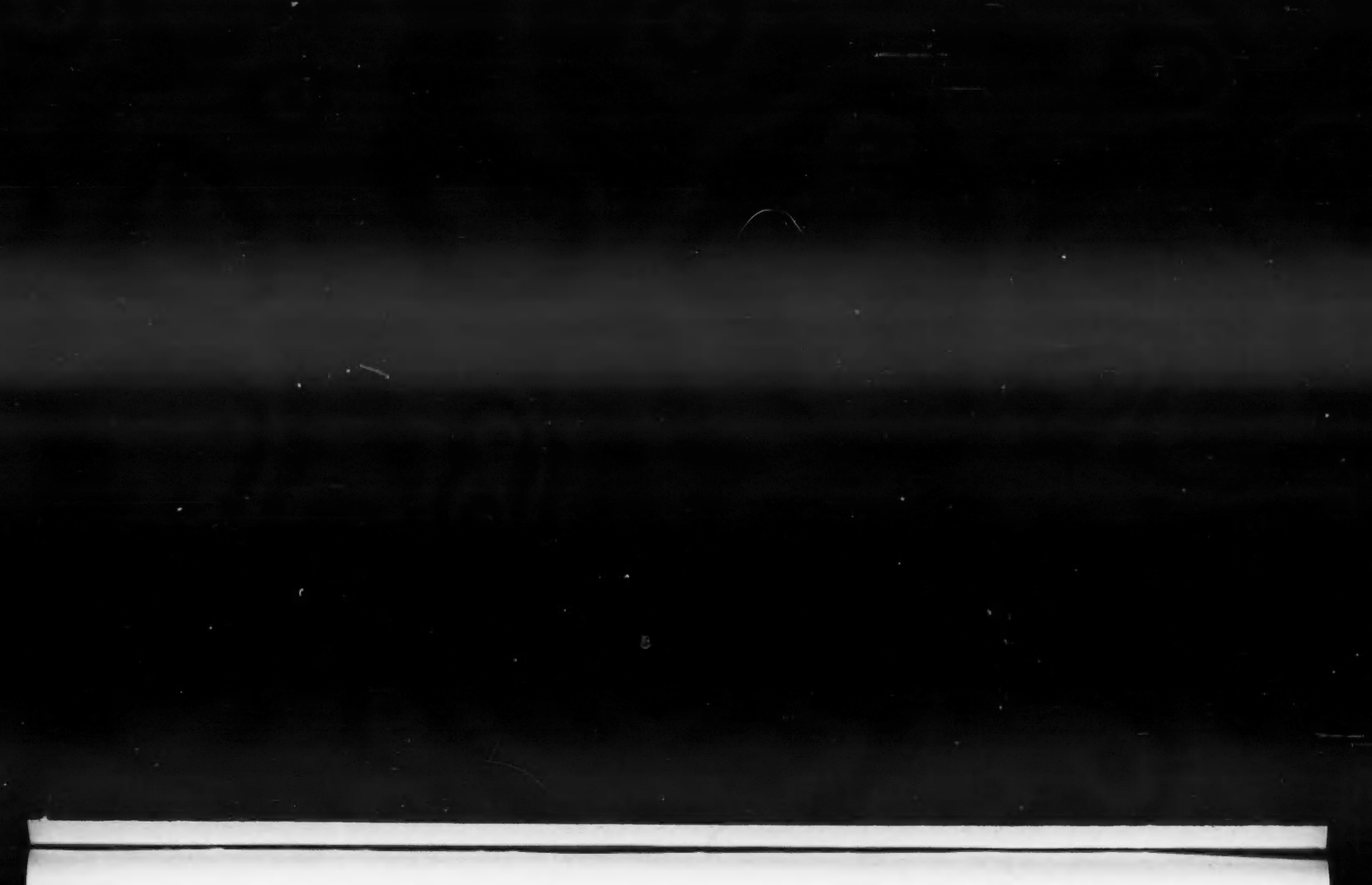
A method for the quantitative valuation of sheet birefringence of comparatively weakly anisotropic materials is described. The results, when interpreted with supplementary X-ray diffraction evidence, afford criteria for the fine structure of cellulosic sheets. It is shown that diminishing sheet thickness increases the planar orientation and that increasing length of aliphatic side chain increases, and then decreases, the positively birefringent contribution. Different types of crystallite orientation associated with sheet structure are characterized, and the particular influence of unidirectional stresses is discussed. (S)

ORGANIC CHEMISTRY OF PROTEINS. J. Overhoff. *Chem. Weekblad*, 1939, V. 36, P. 115–22; abs. in *J. T. I.*, Feb. 1940, P. A118.

A description and discussion of recent experimental and theoretical advances in the constitution of proteins. (C)

PHYSICOCHEMICAL STUDIES OF THE DISTRIBUTION OF THE DEGREES OF POLYMERIZATION IN CELLULOSE. I. THE METHOD OF FRACTIONAL SOLUTION OF CELLULOSE. Hans Dolmetsch and Friedrich Reinecke. *Zellwolle u. Deut. Kunstseiden-Ztg.*, 1939, V. 5, P. 219–27. II. Investigation of the Distribution of the Degree of Polymerization of Some Natural and Commercial Celluloses. *Ibid.*, P. 299–307; abs. in *J. T. I.*, April 1920, P. A201. (C)

PROTEIN MOLECULE: A DISCUSSION ON THE. *Proc. Roy. Soc.*, Mar. 16, 1939, V. 170A, No. 940, P. 40–79; abs. in *Eastman Kodak Abs. Bull.*, Nov. 1939, P. 602.

The discussion reported was held by the Royal Society on Nov. 17, 1938. The opening address by Svedberg was devoted to a survey of recent techniques in protein chemistry, and the evidence for the existence of protein molecules. A table of molecular constants of proteins is provided. Contributions to the discussion are devoted to such topics as enzymes, structure of the protein molecule, X-ray data, denaturation, and certain biological aspects of the subject. (S)

PROTEIN MOLECULE: STRUCTURE OF THE. D. L. Talmud. *Acta Physicochim.*, 1939, V. 10, P. 753–74 (through *Brit. Chem. Abs. A*, II, 1939, P. 525); abs. in *J. T. I.*, Jan. 1940, P. A65. (C)